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Plastics

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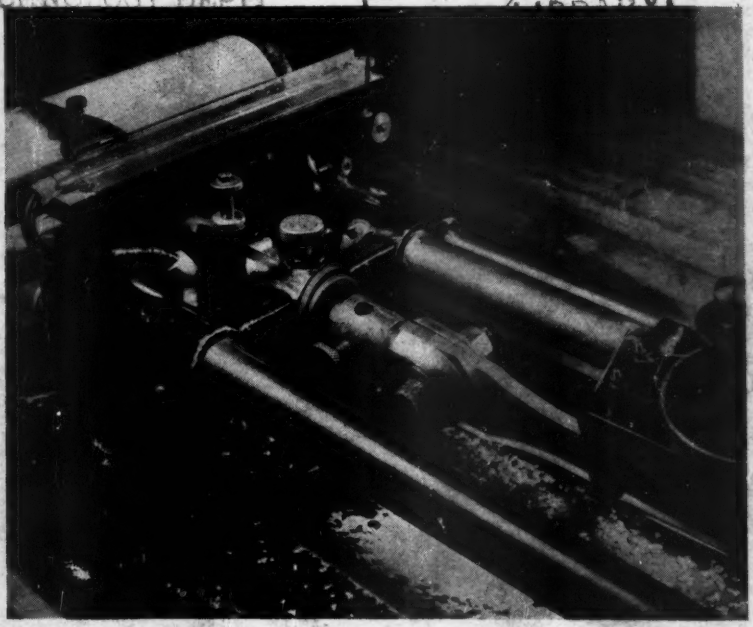

Test of Strength

Tensile strength tests are routine practice on all I.C.I. plastics. The Hounsfield Tensometer, the machine used for the purpose, was originally introduced for the testing of metals. It is shown in the photograph with a piece of "Perspex" under test, the tensile force being measured by the displacement of a mercury column in a glass capillary. The machine also registers the extent of deformation of material under stated loads — thereby providing information of great value to designers. Information on I.C.I. plastic materials will be supplied on request

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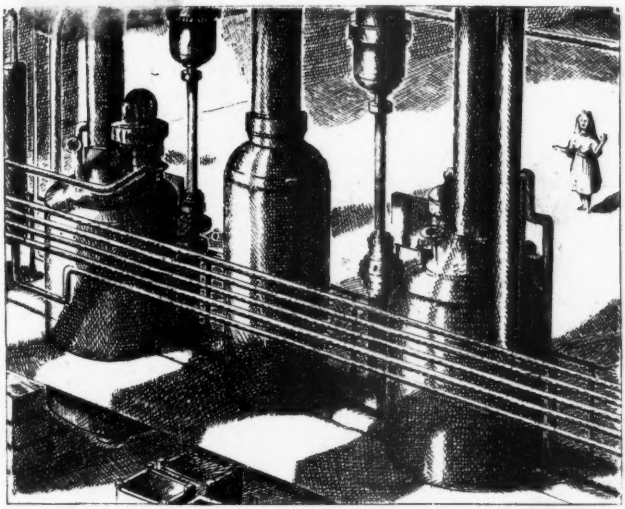
Tech.

Alice in Plasticland—No. 9



Alice amongst the Cauldrons

"Fire burn and Cauldron bubble," quoted Alice to herself, thinking for a moment that she had strayed out of Wonderland into the fourth act of Macbeth. But no, this was merely the place where the resins for Elo plastics are prepared. The molten material running off into trays reminded Alice of Toffee. She felt quite minute before the huge cylinders, as though she had swallowed some brew as potent as the resin and suddenly shrunk. Rather awed, she wandered along to the department where the Moulds for Elo plastics are made.

ELO

PLASTICS

Full reliable information and data from Research Section. BIRKBYS Ltd., Liversedge, Yorkshire

CRYSTALATE LIMITED

Sir Herbert Morgan's Speech

The annual general meeting of Crystalate, Ltd., was held on December 21, in London.

Sir HERBERT E. MORGAN, K.B.E. (the chairman), said that the directors' proposals for the reconstruction of the capital of the company would be placed before the shareholders early in the New Year at an extraordinary general meeting.

The profit of the parent company, before charging taxation, was £44,685, and after deduction of tax the net profit shown of £11,385 was slightly higher than last year. The liquid capital position was £98,229, as compared with £93,027 last year.

In the directors' report they showed the profits of The British Homophone Co., Ltd., and Ebonestos Industries, Ltd. Those, before taxation, were again higher by £6,000, but the taxation charge was almost doubled at £34,000, with the result that the profits, after taxation, were some £10,000 lower at £9,000. That arose from the fact that last year the income-tax and E.P.T. deficiencies were exhausted.

Last year they had practically reached the maximum turnover of which their factories and plant were capable under the conditions existing. When that was borne in mind it would be seen that no great increase in the profit figures was likely to occur in the near future. The company was primarily engaged as plastic moulders, and in the main they were limited to the production of small parts, which were used in sections of other units, the orders for which came from manufacturers in industries outside the plastics trade. Their sphere was to co-operate with them and to assist as far as the plastics section of their goods required. There was every reason to believe that the manufacturers they served could look forward to a period of large-scale demand in order to satisfy the essential requirements of the world.

Importance of Export Markets

The companies referred to were naturally considering the opening of export markets, a problem which was greatly exercising the Board of Trade to-day. The commercial community welcomed the appointment of the powerful committee which had been formed to advise the Department of Overseas Trade. He trusted that one of the first findings of that committee would be that the department deserved encouragement and support and that, as at present constituted, it was inadequate to grapple with the problems confronting it. When one realized that the Government were spending less on the Department of Overseas Trade than many individual firms spent on developing their own business, it demonstrated the need for much greater effort.

Plans for the increase in their export trade to secure an additional 50 per cent. over the pre-war standard must be on a bold, impressive and grand scale. No other phase of business depended more on personality than the export trade. Therefore the Government, as well as industry, must be represented by the best type of men and women available. Naturally, many of those were now serving in the Forces or engaged on Government work, and their release should have priority the moment the state of the war made it possible. The committee would also doubtless urge for the earliest consideration being given to the release of designers—of key men and women. They were vital to the development of new industry and new products. They were the basis, the start, of initiation, and months were required before their designs took practical shape and were on the production lines. It must be emphasized that their designs and the resulting tools came first, and production of new articles would be stagnant until those took effective shape.

Their warmest thanks were due to Mr. Jack Lesser, their managing director, and to the executive and staff of their three factories who loyally supported him.

The report was unanimously adopted.

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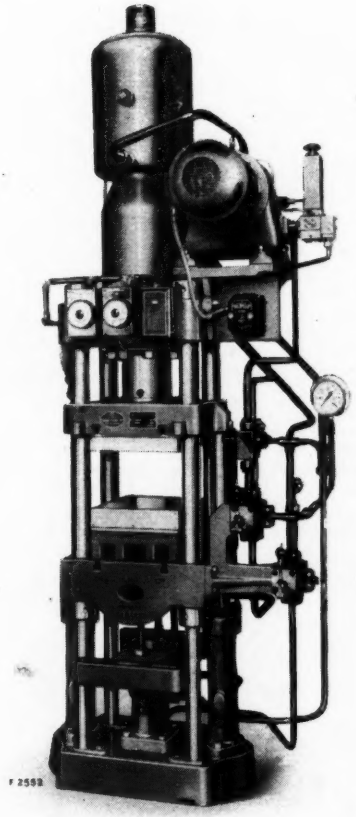

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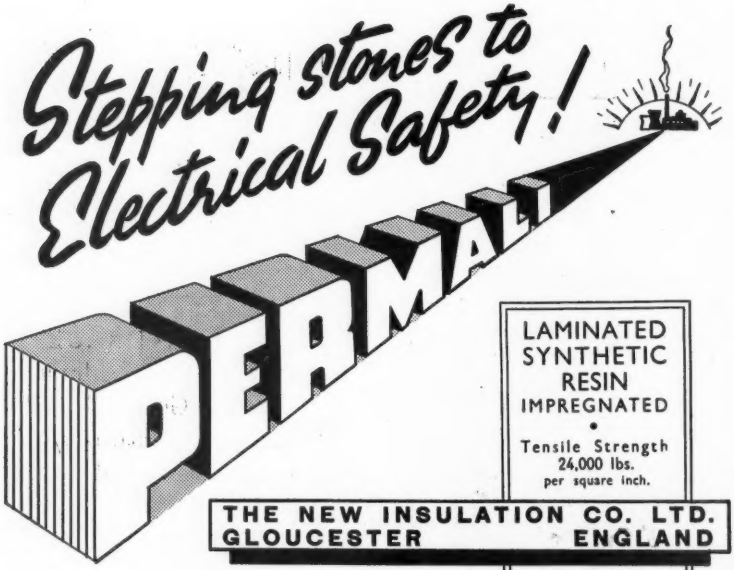

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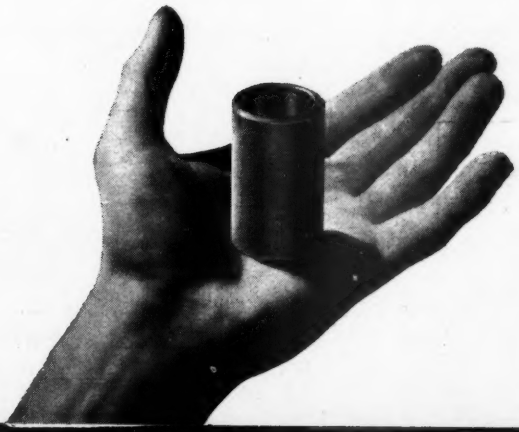

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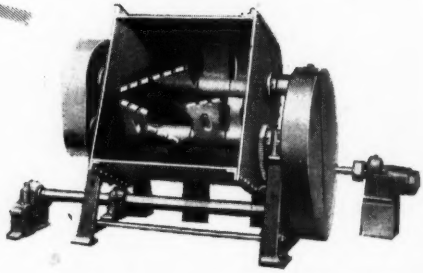

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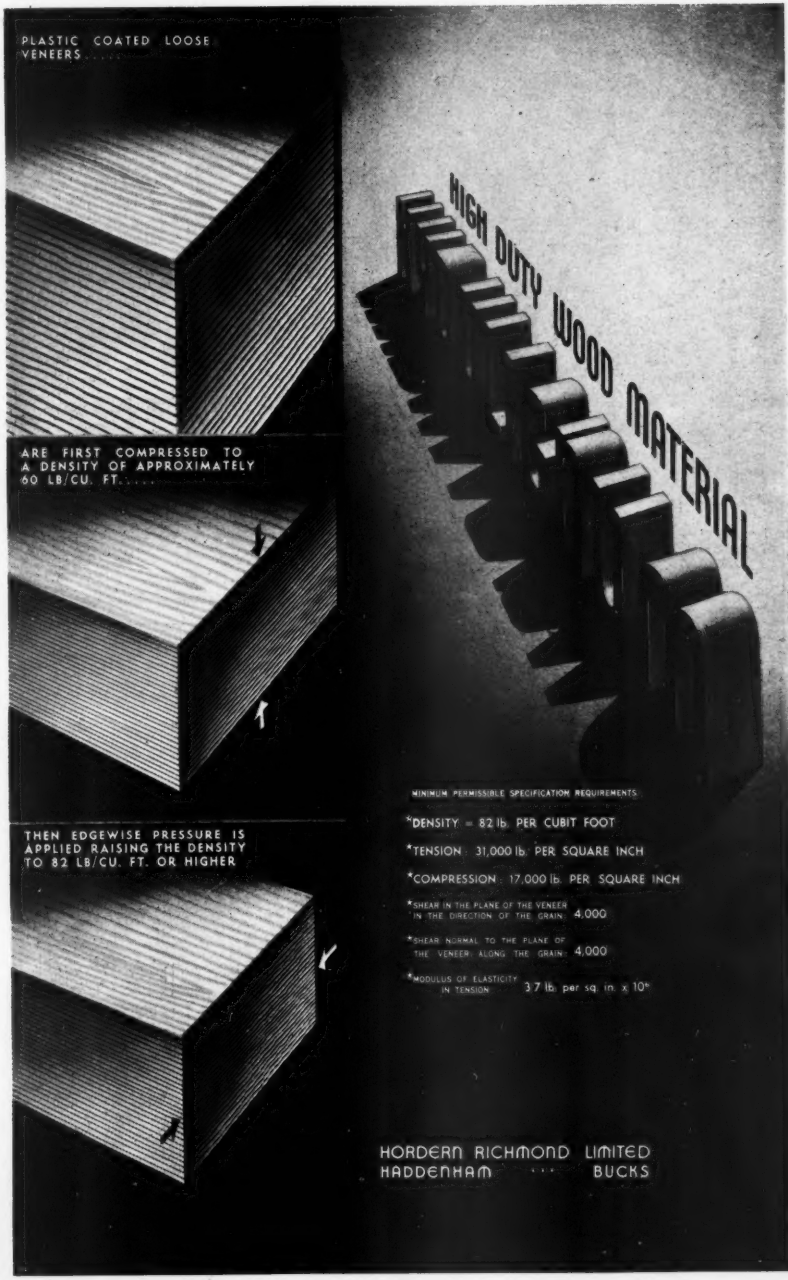
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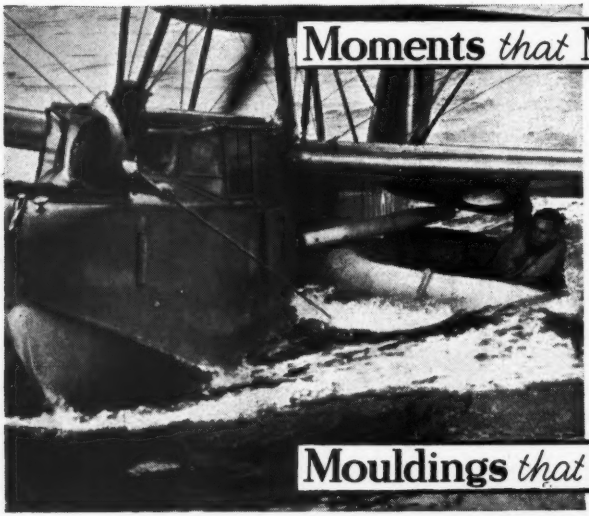

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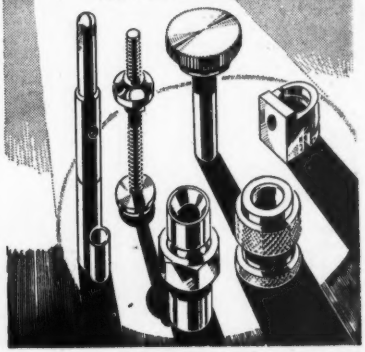

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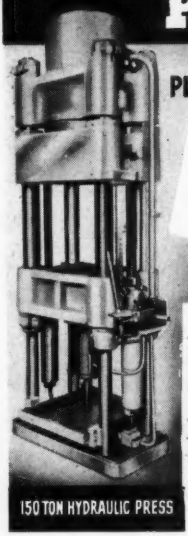

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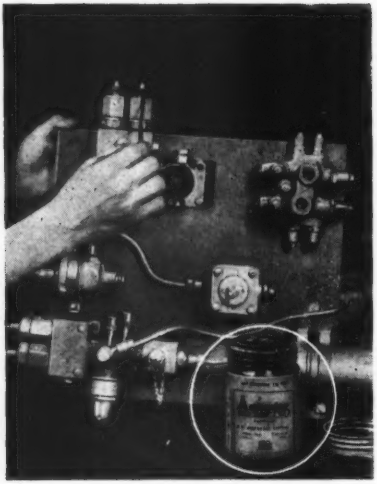

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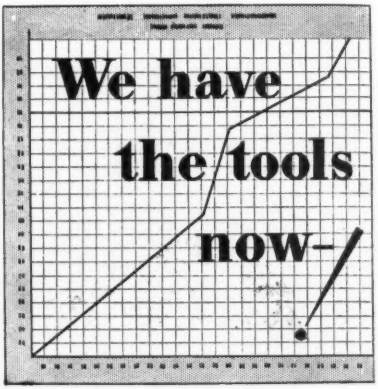

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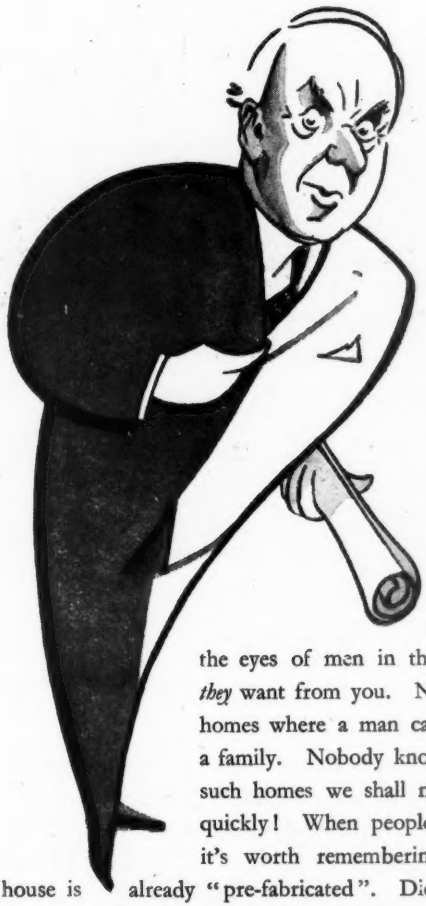

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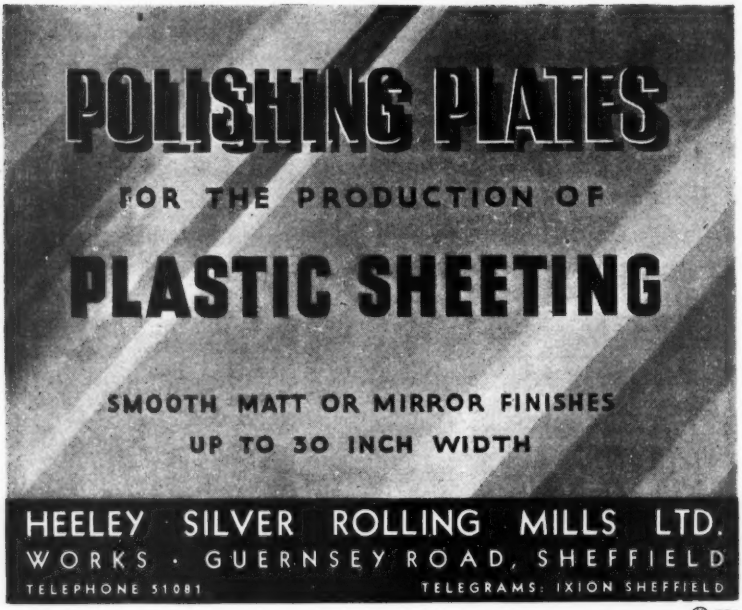

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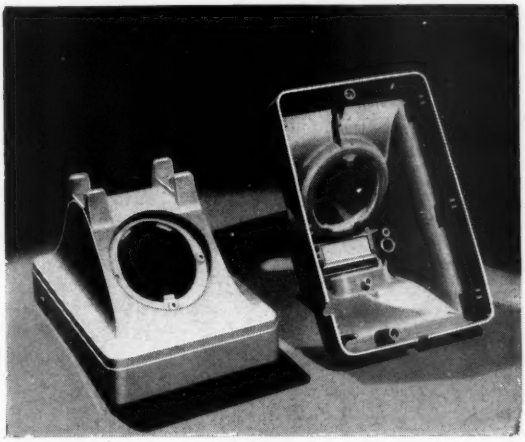

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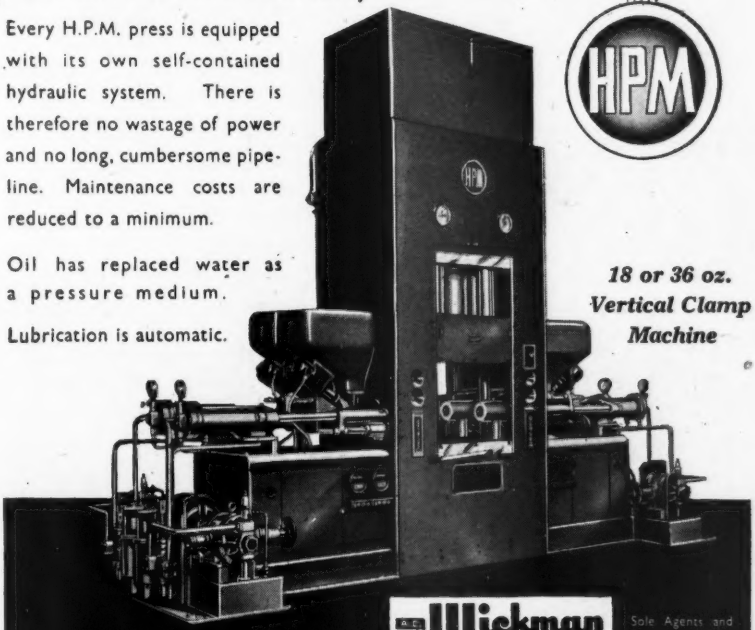

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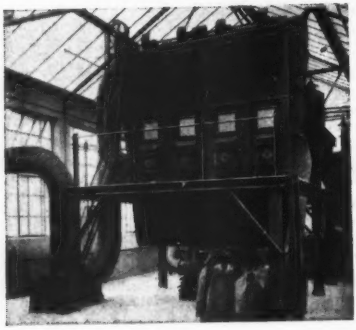

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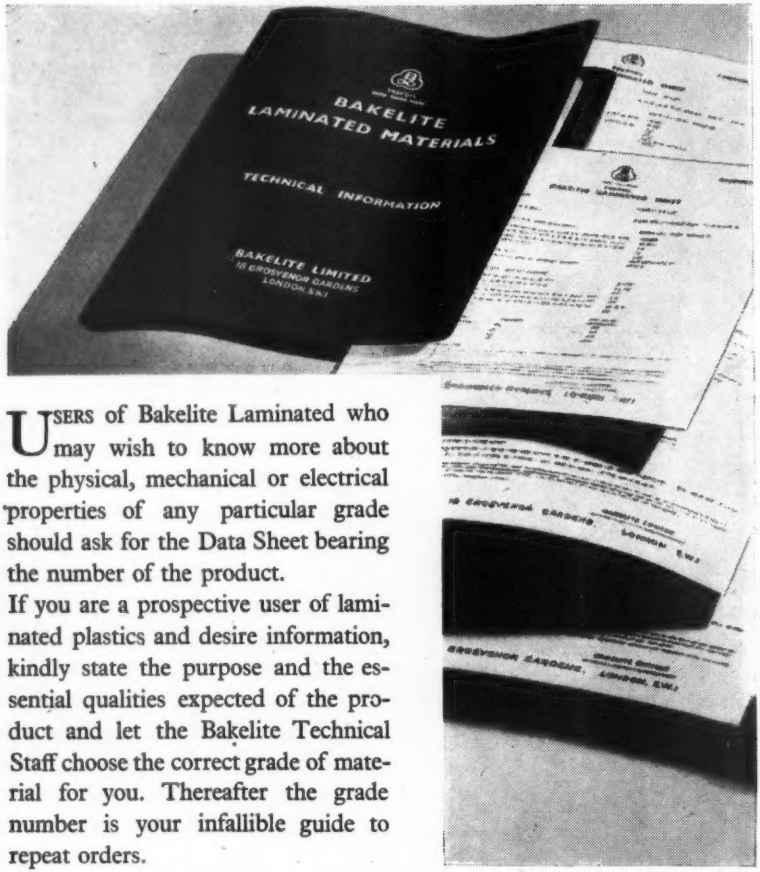

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Vol. IX. No. 92 JANUARY, 1945

Plastics

Dealing with the Manufacture, Uses and Potentialities of Plastic Materials

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NOTICES

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SAVE PAPER

More than ever is paper waste required for our war industries. Waste paper makes munitions in a hundred forms—from shell cases to aeroplane parts.

The fact that goods made of raw materials in short supply because of war conditions are advertised in this journal should not be taken as an indication that they are necessarily available for export.

EDITORIALS

New Exhibitions?

WE have had a request from Selfridges through its sales manager, Mr. E. W. Gilland, to co-operate in the creation of a plastics exhibition, which it is hoped can be shown in the fairly near future in Oxford Street. The aim of the exhibition will be to show the public what plastics can do for the home in the post-war years. There would be no suggestion that new materials are now available for general use.

This is a one-in-a-million chance for the plastics industry, especially since Selfridges are willing to defray the showing costs. Those with whom we have discussed the matter agree that it is a fine opportunity and would give wonderful publicity to our goods.

Mr. Gilland is quite aware of the fact that our industry is almost entirely occupied with war production, but he is equally certain that, with good will and an extra effort, special samples can be produced. With this we concur, and we shall approach the industry for its ideas on the whole subject. We do hope that the response will be helpful both in ideas and as regards samples.

Already Mr. Gilland is occupied in the making of an Aluminium Exhibition, which will probably be held about April next. The aluminium industry is most enthusiastic about it and has already started on producing exhibits. What is extremely interesting and foresighted is the decision that the exhibits should where necessary or apposite contain examples of aluminium/other material combinations. Thus, at a recent meeting of the Exhibition committee, a representative of the British Aluminium Co. stated, with the concurrence of everybody present, that aluminium should be allied with plastics where such a combination was an improvement over aluminium alone. Plastics reinforced with aluminium, aluminium chairs covered with plastics and plastic finishes on aluminium were suggested.

This is, indeed, liberal thinking.

The Science of Saving Waste

FEW people on passing a slag or coal-dust heap or the waste from a big wood-working factory can resist saying: "Why doesn't somebody use it all? There must be a lot of money to be made when you can cart it away for nothing."

The problem is not so simple as it seems. It is generally very involved and highly technical, and high cost of transport of bulky materials may kill many a brilliant idea.

However, the story of chemical science is full of successful uses of "waste" materials which have become important.

In this country there is little incentive to recover wastes, although many inventive persons have made much money by such means. Glycerine was a waste of soap manufacture, lanolin of the wool-washing industries, fertilizer from waste fish, and, of course, valuable substances have been made for over 70 years from "waste" coal tar. The number of such instances is very great even here.

But of all countries which systematically examine wastes or so-called worthless materials, Germany has always been in the forefront. The present war and the German Four-year Plans before it increased this search enormously. How far the new processes are economically successful we cannot, of course, say now, but they are certainly fascinating. There has recently been published in this country a translation of a German book entitled "Verwertung des Wertlosen" ("Making Valuable the Worthless"), by Claus Ungewitter, a unique technical record of Germany's stupendous achievement in salvaging every kind of waste and

of utilizing many strange raw materials to produce valuable compounds.

The translation is by L. A. Ferney and G. Haim (who is already known to our readers), and is published under the title of "Salvage and Science."

The book deals with an amazing variety of raw materials, some of which are frankly well known and have made long-established industries; for example, the production of helium, neon and argon from the air, sugar from wood waste, metals from flue dusts, bromine from sea-water, phenol from coke-oven waste water, building materials from slag, recovery of solvent vapours, and so on. In addition, we read of the possibilities of utilizing peat of methane production from sewage, chromium from tanning wastes, of metals from coal ashes.

Of more immediate interest to the plastics industry are the notes on the use of peat as a filler or for producing yarns, of the use of waste woods and sawdust for making building board (an interesting report states that a combination of plastics, sawdust and peat is being successfully used).

Lignin is being very closely studied in Germany, for it can be condensed with phenol, amines, aldehydes, chlorinated hydrocarbons, or furfural to produce thermoplastic resins. An addition of 8-12 per cent. of phenol-lignin to sawdust results in a composition which can be moulded at 200 degrees C. It would appear that 1,000,000 tons of lignin can be extracted from German sulphate process.

An interesting raw material from the sulphate processes of pulp manufacture is "tall" oil, which consists mainly of fatty acids and resinous acids. This can be made to react with glycerine to produce a quick-drying varnish. While only 1,000 tons a year were produced in Germany in 1938, probably this amount has been increased considerably, for, without doubt, this was one of the important methods German industry employed to offset the necessity for importing linseed and other drying oils.

There is also an excellent chapter on the utilization of agricultural wastes, which includes the various materials, straw, potato haulms, hop vines, flax and hemp shives, etc., which can be employed for cellulose production. It is from some such sources that much of our raw material must come.

This book is exceedingly important to us now, and will increase in importance, no doubt, after the war. We are greatly indebted to the translators for their excellent work.

"Science and Salvage," by C. Ungewitter. Pp. 183. Published by Crosby Lockwood. Price 12s. 6d. net.

Moonshine and Green Cheese

Now we really know the secrets of the manufacture of Bakelite. One Richard Eastham, writing a terribly important article in "The Llandudno Advertiser," tells us how many of the most useful scientific discoveries were quite accidental. We have heard the claptrap of the mouse-trap before, but up to now nobody's blamed Baekeland for it.

"For instance," says Eastham, "it was a curious mishap which was responsible for the discovery of bakelite. One evening, Leo Baekeland, a Belgian research chemist working in America, baited a mouse-trap and unintentionally left a piece of cheese on his laboratory table. During the night, a cat entered the laboratory, jumped on the table and upset a bottle of formaldehyde. The liquid saturated the cheese and transformed it into a hard glossy substance quite insoluble in water and non-inflammable.

"Next morning, when Baekeland found this remarkable new material on his table, he decided to investigate its possibilities, and after a long series of experiments he produced 'bakelite,' the solid plastic with innumerable uses which has given rise to an important modern industry."

Perhaps Mr. Eastham will pursue his important researches and tell us of the secret within the secret—was it Gorgonzola, Brie, Camembert, or just plain Kraft?

A new optical use for transparent plastics, applied to War Office requirements

CORNER CUBES

A NEW optical application for plastics has been developed by Imperial Chemical Industries to meet an urgent Service requirement. In November, 1943, there was a sudden demand for special tetragonal prisms in large quantities, for applications connected with the invasion of Europe. Glass prisms had been considered, but insufficient glass-working equipment was available to allow deliveries to be made at the required rate. The only way in which the many tens of thousands of prisms could be prepared appeared to be by the use of a transparent plastic, and I.C.I. were asked to consider the manufacture of these corner cubes, as they are called, in "Transpex," the special optical quality of the methyl methacrylate sheet usually known as "Perspex."

The corner cube is a fairly old optical device which was used successfully in the last war. Imagine an accurate cube cut from a block of transparent material, and a prism formed by cutting off one corner of this cube, followed by polishing this sheared face. This corner cube has the property of reflecting back along the same path any light ray which is incident upon the sheared face by reason of the inclination of its faces relative to each other. Thus, a person shining a torch into the prism from any reasonable angle will receive back a strong reflected beam and, provided that the angles of the original cube from which the prism had been cut were sufficiently accurate, no rays would be scattered in any other direction. The maximum angle of incidence from which a reflected beam will still be received will depend on the "critical angle" which is itself determined by the refractive index of the material.

The Problems of Manufacture

The number of prisms required in a short period was enormous and demanded some rapid method of preparation. The first problem to be studied was the accuracy of the angles of the prism which would give the most suitable reflected beam distribution for the application in question. Corner cubes, with the required one-inch edges, of varying degrees of accuracy were prepared from blocks of "Transpex" in the laboratory. Prisms of high optical accuracy gave most remarkable effects, it being possible at 100-ft. range to bring back the rays to within a 4-in. diameter circle round the source of light, with practically a complete black-out at any point outside this circle. Inside this circle, the reflected beam was brilliant. The War Office stated, however, that, while a strong reflection was needed, there was also need for a reasonable spread in the reflected beam and, moreover, the area of the prism must appear to be evenly illuminated. Sample corner cubes finally submitted and agreed as satisfactory had angles accurate to two minutes of arc with a certain amount of wave in the surfaces to give a further increase in the spread of the reflected beam. Such "Transpex" corner cubes gave a reflection from an

ordinary pocket torch which could be seen quite clearly at a distance away of more than 150 yards, while the limiting angle of incidence to the normal was 55 degrees.

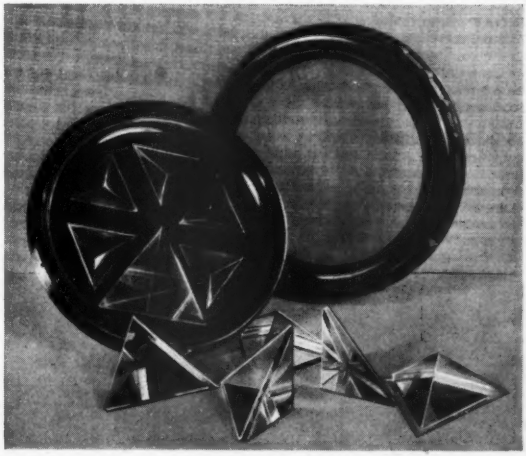
Machining Difficulties Rapidly Overcome

Much experimental work was necessary before a sufficiently rapid method of manufacture was devised. It was finally decided to use a high-speed milling machine, worked under conditions to give a smooth machined finish to the prisms, followed by a light buffing. Two-inch wide strips were cut from sheets of " Transpex," ¾-in. thick, by a band saw. Roughly shaped prisms were sawn from these by means of jigs. A bank of 15 small specially designed milling machines was prepared and ran at 6,000 r.p.m. The rough prism was clamped in a holder at the correct angle relative to the cutting tool, which carried it along automatically until the machining on that particular face was completed. A considerable quantity of cooling liquid was used throughout the machining to prevent burning of the surface of the " Transpex." As soon as that face was completed, the prism was turned round through 120 degrees to allow the next face to be machined and so on, until the three faces were completed. The fourth face, the one to be exposed to the incident rays, was the original face of the " Transpex " sheet. After machining, the angles of the prism were tested by means of a device capable of reading to five seconds of arc. Any prisms showing inaccuracy were rejected. The machines were capable of machining 6,000 corner cubes per day. After machining, the surfaces of the prisms were so good that a short buffing with rouge gave a highly polished finish. Light reflection tests showed that the cubes made by this method gave the required performance, and the machining conditions were maintained so accurately that it was found possible to dispense with a routine light test and rely solely on the angle test at the machines.

For Service use, the corner cubes were required mounted in cases containing single and six prisms respectively. It was specified that the cases should be robust, to withstand the rough usage they were likely to get and capable of being attached easily and rapidly to a wooden stake driven into the ground. Accordingly, it was decided to mould heavy cases in phenol formaldehyde, each containing accurately shaped compartments in which the corner cubes would sit. The cases were closed by screwing down a moulded ring, containing a " Perspex " front disc with a rubber washer to act as a cushion round the edge of this disc. The case was sealed round the joints with a sealing compound to make it waterproof. The case containing a single corner cube had a wood screw moulded into the back, so that it could easily be attached to a wooden stake. The multiple case had a deep groove moulded into the back, which was designed to lie along the wooden stake, and a strong spring across the groove slipped over and gripped the stake.

It was only possible to complete the work in the very short time allowed with the willing co-operation of the sub-contractors. The instruction to proceed was received at the end of February, 1944, and early in September the full quantity required had been manufactured, in spite of the fact

(Continued on p. 32)



Breakdown of phenol formaldehyde mould containing six "Transpex" prisms.

Plastic-applied "Coatings" by Spray and Dip

The Present Position and Future Possibilities of Directly Applied Plastic Films

By E. E. HALLS

THE use of organic films produced by the application of enamels, lacquers, paints or varnishes in an appropriate manner is universally recognized. Such films are employed for decorative purposes, in which case they play a rôle with respect to the protection of the underlying surfaces, or, again, primarily for reasons of protecting the material to which applied. The nature of the protection demanded is always dependent upon the service conditions in which the work so treated is destined to operate. Moisture proofing and resistance to corrosion are the two general objectives, and usually they are interconnected. Metal work is finished with organic media to preserve it from corrosive influences, or, at least, to delay deterioration. A moisture proof adherent coating having qualities of toughness, elasticity to resist shock and vibration, and free from natural propensities to age and become embrittled, flakey or powdery, is required. Resistance to chemical fumes, liquids or solutions, and resistance to oil and petrol or other solvents, may also be necessary. Again, stability under exposure to strong light, to fluctuating conditions of dampness or dryness, warmth or cold, may be involved. Similar requirements appertain to coatings upon non-metals, such as paper and card, concrete and ceramic, brick and stone, felt and fabric. Moisture proofness is a predominating requirement.

At one time these coatings were obtained from resins and gums in suitable solvents, such as methylated spirit, or from drying oils, linseed oil, etc., modified by resin or gum additions, and rendered suitable for application by adjusting the consistency with volatile solvent, such as turpentine. More recently the synthetic plastics have entered this field, and have not only acquired much of it previously catered for by the natural resins and gums but have enabled it to be extended considerably. The thermoplastic resinous materials, nitro cellulose, cellulose acetate, polyvinyl products, ethyl cellulose, polystyrenes, etc., have formed the basis of air-drying media. Resins and gums to modify properties of adhesion and flexibility, and likewise plasticizers, have been incorporated. Application has been by such methods as spray, dip or brush, and film formation has depended upon solvent evaporation at normal temperatures. The thermosetting resins, phenolics, aminos and alkyds are similarly utilized. They may or may not be modified with drying oils, and again depend upon solvent evaporation to produce the desired coating. Drying may be at room temperature or by baking to a predetermined stoving temperature in accordance with their formulation.

The bulk of domestic finishing media is applied manually by brush. Most industrial media are applied by spraying from appropriately designed guns, but many use dipping methods.

The use of the plastic base directly without employing a solvent medium offers many obvious advantages and, perhaps, an equal number of not so obvious disadvantages. The latter will be discussed later in this article, and attention at this stage confined to the advantageous features. These can be grouped as under:—

1. The orthodox media entail the expense of obtaining a solution of the plastic base in solvents, and later the expense of removing these solvents. A

host of technical problems are always associated with both of these stages. Time, labour, plant and space are all required. Consequently, the avoidance of solvent should assist towards more rapid working, both in manufacturing the medium and in using it, reduced labour effort, simplified plant and less space.

2. Fire risk would be reduced and health hazards minimized. Both these factors apply to manufacture and use of the medium and the first additionally to the transport and storage of it. Simplified exhaust systems should be possible, and in general a betterment in working conditions.

3. Only that percentage of the orthodox medium represented by the total solids, including the plastic base of resin, gum, oil, pigment, etc., contributes to film formation, and, therefore, there is a contraction from the condition of the film as applied to that when fully dried. This contraction is a disadvantage, and occasions arise when this gives rise to problems of a serious nature.

It is evident that the direct application of plastics overcomes these shortcomings, but not without introducing other problems that have had to be solved or which still remain to be solved. The present position is that directly applied plastic finishes, particularly sprayed coatings, are exploited fairly extensively. Such applications depend upon specific merits, and usually where the orthodox media are not apt or do not fulfil the conditions so well as could be desired. Some considerable progress has yet to be made before such materials and processes can compete with, or substitute, the already established procedures.

Consequently, it can be stated that, apart from the use of the various synthetic resins in solvent vehicles for metal finishes, wood finishes, etc., the pure synthetic resins, or resins suitably plasticized or pigmented, can be applied directly. All such applications at the present time are very much in their infancy, but development can be anticipated.

Of the thermoplastic synthetics, polythene is the outstanding one that has been applied quite successfully. It is used in powder form and sprayed from a flame gun. Shellac has been used extensively in this manner, and in particular special compositions of shellac and asbestos or shellac and mica. Bitumen is another natural or semi-synthetic plastic product of which the spraying has been thoroughly established. Here, again, the material is used in powder form and applied by means of a special gun. Also, the so-called synthetic rubber "thiokol" is applied as a surface coating for corrosion protection by means of the flame gun.

Again, much experimental work has been done on rubber and on rubber sulphur mixes to give the equivalent of soft to hard rubber or ebonite linings, which are employed for chemical protection of wood and metal. The phenol-formaldehyde resins, bakelite type, have also been investigated and successfully applied in an experimental manner, with the object of applying the resin and curing during the process of application.

There are, of course, limitations to a process of this nature, limitations set by the nature of the plastic sprayed and its resistance to heat. The more logical development would be the use of liquid plastics, that is, solventless media consisting of a plastic suitably plasticized and, if necessary, pigmented and probably partially cured, so that it could be applied by brush, dip or cold spray in the manner normally used in paint and enamelling shops, and then the coating could be finally cured by a normal type of enamelling oven process. Anything along these lines has yet to be commercialized. This type of solventless medium would be welcomed in the electrical industry for the treatment of wound coils. It would enable the windings to be impregnated under vacuum, or vacuum followed by pressure with a liquid, none of which has to be driven off by heat, and, therefore, the voids associated with the use of ordinary varnishes due to the solvent that has to be driven off would be avoided. A number of practical difficulties associated with the use of such materials, for example, the

tendency of a thin medium to drain out from the winding before it has been cured, would have to be overcome, but none of these difficulties should be insoluble.

Patent Literature

The patent literature upon the subject of spray application of solid plastics is very interesting. One specification completed as recently as 1943 deals with polythene powder suitable for application by means of a flame gun. Other patents between 1939 and 1941 cover the spraying of resins, synthetic or natural, bitumen or bitumen compounds, rubber and rubber compounds. Some details from these are included in the following, because they are of both technical and general interest.

B.P. No. 551,339, February, 1943, due to the Imperial Chemical Industries, Ltd., covers a process for coating surfaces with solid polythene by projecting or spraying the solid polythene in powder form through a flame gun on to the surfaces to be coated. It points out that polythene consists of polymers of ethylene, which in composition correspond substantially to the chemical formula $(CH_2)_x$, and that these polymers may be solid or semi-solid or grease-like at ordinary temperatures.

The patent refers only to those varieties solid at ordinary temperatures.

The surfaces included are varied and comprehensive, embracing metal, cloth, wood, paper, brick and cement. It is claimed that such surfaces can be coated with polythene by spray through a flame gun to give coatings which are continuous, highly adherent and protective. The coatings possess excellent electrical properties with respect to insulation and breakdown. They also have excellent chemical characteristics, being extremely resistant to corrosive materials and to solvents.

The process simply comprises the spraying or projection of the solid polythene in powder form through a flame gun on to the surfaces to be coated. Satisfactory results are obtained using the type of gun in which the polythene powder is carried by means of a stream of air into the gas flame and directing the resultant blow-lamp flame, through which the particles of solid polythene pass, on to the work surface. Decorative coatings can be secured by the incorporation of appropriate pigments in the polythene powder.

An example is given of the mode of formation of a suitable polythene powder. A solid polythene of softening point less than 110 degrees C. is milled below 110 degrees C. on a rubber mill with the rolls heated at 110 degrees C., the nip being small, until the material forms a semi-fluid mass on entering the nip side. Cooling water is then passed through the rolls, and the milling is continued until the mass becomes pulverulent. It is then removed from the mill, crushed and passed through a sieve containing 100 wires/linear inch.

An earlier patent on the subject of spraying artificial or synthetic resins, but which does not specifically mention polythene, is B.P. No. 538,203, July, 1941, due to C. F. Lumb. It claims a method of producing homogeneous coating or layer of an artificial or synthetic resin on the surface to be treated by spraying the resin in a finely divided or powdered state by means of a pistol or spraying apparatus, in which air or gas under pressure is used to direct the material in a stream through, or adjacent to, the flame at a temperature sufficient to melt the resin or to render it plastic and adherent to the surface in the form of a coherent film without the need for a subsequent baking operation. The resins specifically mentioned are phenol-formaldehyde, urea-formaldehyde and alkyd types. The body of the specification mentions that a plasticizer may be included. It points out that temperature is dependent upon the synthetic resin used, as well as upon distance of the pistol from the surface and the air or gas pressure. As an example, a temperature of 140 degrees C. at the point of contact of the flame and the work is given.

As a suitable spraying pistol, B.P. No. 432,831 is cited.

The patent excludes rubber and bitumen, and cross refers to Nos. 473,184 and 507,057, which cover these items in a similar fashion. No. 507,057/1939 also covers a mixture of powdered rubber and

a moulding powder, such as phenol-formaldehyde with, or without, other fillers. Powdered rubber and bitumen with, or without, filler is also covered. Fillers include calcium carbonate, lime, zinc oxide, and powdered carbon or coke. The inclusion of a vulcanizing agent such as sulphur is likewise incorporated. No. 473,184/1937 covers bitumen with, or without, filler, and specifically refers to 33 per cent. bitumen or bituminous compound plus 67 per cent. calcium carbonate. It also embraces the inclusion of copper or copper sulphate, arsenic or arsenious compounds as anti-fouling agents. The specification cross refers to a prior one, No. 354,544, which covers the spraying of any resinous or varnish base body, followed by the gradual raising of the temperature of the coated surface for conversion to an adherent and coherent film.

The processes referred to in these patent specifications are evidently closely associated with the well-known Schori powder pistol, which is firmly established for metallizing processes, and is marketed by Schori Metallising Process, Ltd. This concern markets the piston and equipment for use with the various powdered resinous materials to which reference has been made. A closely similar procedure is employed for bitumen, the development rights for the gun for this being controlled by Messrs. Prodorite, Ltd. Bitumen coatings sprayed by the Schori patented process are referred to as "gunned bitumen," and The Consolidated Bitumen and Allied Industries, Ltd., are expert in the application.

The following notes and illustrations appertaining to the process for spraying bitumen are taken from "Building," in the October, 1940, issue of which appeared brief notes under the heading of "Gunned Asphalt," and from the brochure entitled "Gunned Bitumen Compounds and Structional Impermeability by the Schori Patent Process," issued by Prodorite, Ltd., and Consolidated Bitumen and Allied Industries, Ltd.

Fig. 1 shows a close-up view of the Schori spray gun for bitumen, and it demonstrates its close similarity to the powder metal spray pistol. Lightness of weight, ease of handling and manipulability, and complete start-stop control of the powder flow by means of the thumb of the hand which holds the gun covering the orifice are its outstanding design features.

Fig. 2 is a complete plant, compact and mobile. The powder to be sprayed is loaded into the container (C), from which it is fed to the gun-nozzle (E),

Fig. 1.—The Schori spray gun designed for powdered bitumen.

where is passes through the flame, adjusted to give the correct melting conditions, and then carried by means of compressed air to impinge on the surface to be treated. The flame is maintained by means of gases from cylinders (DD), the tall one being oxygen and the other the combustible gas (propane or "propagas"). Reducing valves and pressure gauges are provided in order to adjust conditions precisely. Air from the compressor is cleaned through the filter (B), and on this line again a reducing valve and pressure gauge is included.

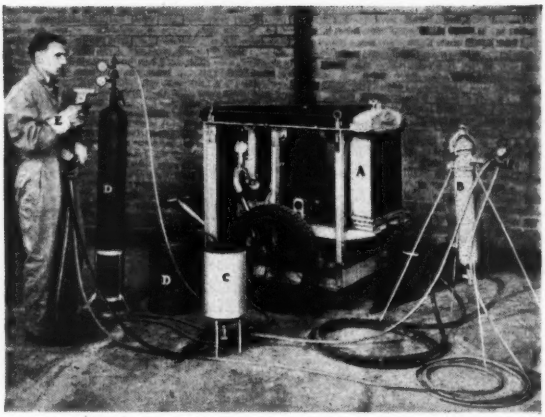


Fig. 2. — Complete mobile unit for bitumen powder spray.

The jet size is adjusted to give a layer of about $\frac{1}{16}$ in. thick per coat, and multi-coats can be built up as desired.

In the case of metal surfaces, these have to be first cleaned thoroughly, as is normal to any "finishing" process. Then a priming coat of special bitumenous anti-corrosive solution is applied. This ensures perfect bonding of the bitumen coat, but, additionally, the spirit carried by this primer has excellent wetting properties, thus ensuring that any pits and crevices are treated efficiently. The priming is allowed a minimum of six hours, and preferably 24 hours, for drying before the bitumen is sprayed.

For concrete and brickwork, which may be "green" or damp, an emulsion type bitumen solution is used for the priming.

Over the black bitumen spray, if a colour coat is required, a spirit paint can be provided, or a white bitumen stop is available, which can be followed by ordinary oil paint.

Fig. 3 shows another complete spray equipment demonstrating its simplicity, compactness and the small floor area involved. Fig. 4 is a close-up view of the gun in action for bitumen spraying.

In Fig. 3, item (1) is the flame gun, (2) is the cylinder of compressed oxygen with valve and gauge controls, (3) the cylinder of compressed propane with similar controls, and (4) is a portable compressor. This supplies the com-

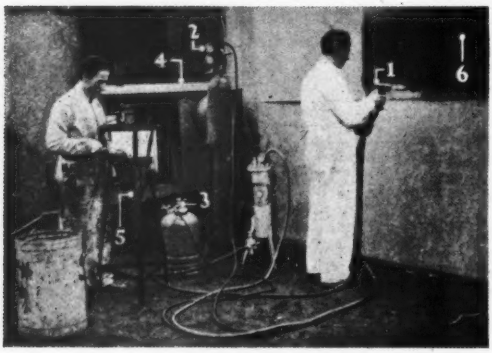


Fig. 3.—Another view of the bitumen spray equipment and—

—Fig. 4.—A close-up of the gun in action.

pressed air to the gun; the air causes the powder bitumen to be sucked from the feed hopper (5) via a supply pipe line by partial vacuum on the injection principle. This air stream takes the bitumen through the nozzle of the gun and the centre of the oxy-propane flame. The particles thus become fused without overheating, and the pressure of the air carries them forward on to the work. The work, shown at (6) is some 8 to 14 ins. away from the gun, which is held almost normally to it. As with metal spray, under correct conditions of operating, the work does not become unduly hot, and no destructive heat is involved, so that materials such as wood and glass can be safely treated. Thus, a sheet of plate glass, which is relatively non-conducting, can be sprayed with a coating of bitumen $\frac{3}{16}$ in. thick and may be comfortably handled immediately.

The gunned bitumen process is made possible by the production of a suitable grade of bitumen in powdered form. This bituminous material is compounded by normal plant technique and resembles a rich mastic asphalt. It is ground to a powder which does not coagulate, that is, it virtually "flows" like a fluid without the individual plastic particles tending to adhere to one another. This type of powdered bitumen is produced in a number of grades which can thus cater for a variety of specific requirements. The applied layer forms a continuous bitumen membrane, which is impermeable to moisture. It is claimed that no temperature slide is experienced even at 150 to 160 degrees F., yet the coating is flexible. It will withstand vibratory movement without any tendency to develop hair cracks. Generally, the gunned bitumen coating provides a really tough layer which withstands an abnormal amount of ill-treatment without losing its efficiency or continuity.

One primary advantage of gunned bitumen is the fact that the process of applying it is applicable to almost any structure, practically independent of its size or configuration. The limitations are those of inaccessible internal surfaces or of structures unapproachable with portable equipment.

The thickness of layer applied can, of course, be varied, and a coating $\frac{1}{16}$ in. thick adds a weight of about 5 lb. per sq. yd. to the structure treated.

Regarding waterproofness, the brochure referred to above gives test results recorded on specimens in the following conditions:—Untreated, 3 coats, 2 coats and 1 coat of gunned bitumen. These specimens were subjected to the pressure of various heads of water for one hour, and the quantity of water percolating through each specimen under each pressure condition was measured. The results are shown in Table 1. These values are reproduced graphically in Fig. 5, from which the value of even single coatings is clearly evident.

Apart from applications concerned solely with waterproofing, the asphalt powders employed can be modified for electrical or chemical needs. The field covered includes, therefore, building,

Table 1.—Water Penetration of Gunned Bitumen Coatings at a Range of Pressures.

Pressure of water		Pressure maintained for	Quantity of water percolating through specimen per hour			
Per square inch lb.	Feet head		Untreated c.c.	3 cts. c.c.	2 cts. c.c.	1 ct. c.c.
20	46	One hour at each pressure	Trace	Nil	Nil	Nil
30	69		60	Nil	Nil	Nil
40	92		127	Nil	Nil	Nil
50	115		166	Nil	Nil	Nil
75	172		244	Nil	Nil	Trace
100	230		320	Trace	1.0	5.5
125	287		377	13.5	15.0	22.0
150	345		418	24.0	27.0	31.0

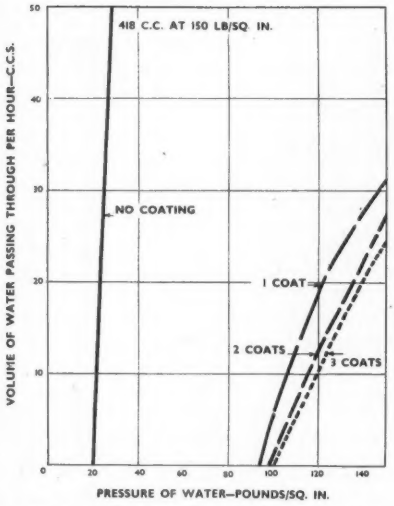


Fig. 5.—Water penetration of "gummed" bitumen coatings.

chemical and electrical, waterproofing of roofs, acidproofing of floors, structures, vats, etc., and the sealing of electrical equipment such as transformers, junction boxes, and the like, are problems that can safely be solved. Of these applications, two seem to have immediate major possibilities. One of them is the waterproofing of large packing cases. These can be sprayed internally with a continuous coating of reasonable thickness, ensuring that crevices and junctions are sealed, and taking the coating over the top edge of the case. The lid can be similarly treated to ensure a bitumen-to-bitumen junction when closed down, finally sealing at the point being obtained by heat. The second attractive proposition is the sealing of transformers in the range of sizes from medium to large. These apparata, after wax or varnish impregnation, usually require an external seal to protect them against the ingress of water through shrinkage cavities and the like, and sprayed bitumen seems to have promise in this direction.

The thickness of sprayed bitumen coatings can be varied within limits to suit the purpose in question, and no difficulties are encountered within the range of 0.003 in. to 0.025 in. It is practicable to control the operation to give a thickness as thin as 0.003 in. per pass of the gun. It is claimed that an oilproof bitumen can be provided.

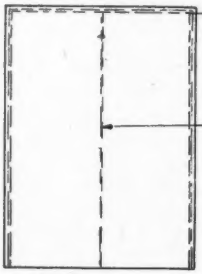
The advent of powder plastic spray adds to the already very versatile character that polythene has established for itself. An all hydrocarbon, pure solid material, a conveniently placed melting point in the neighbourhood of 110 to 120 degrees C., and the fact that the material can be produced in powder form of suitable particle size: these features render polythene eminently suited to spraying through the flame gun. Further, polythene is very stable to heat and no signs of decomposition of it, and no acidity formation, can be detected in the sprayed coating. The coating retains the high electrical properties that are possessed by the moulded material.

Regarding the surface upon which sprayed, the possibilities are very wide. However, the softness of the polythene layer in relation to the hardness of the base material naturally has a bearing upon the "apparent" adhesion of the film. A rough surface naturally provides a better key than a smooth surface; on the other hand, when only certain surfaces of metalwork have had to be covered, and the material has been sprayed upon steel finished with glossy stoved enamel, excellent adhesion has been secured. No signs of peeling or flaking away has been found; in fact, to remove the coating, it has had to be scraped off with a knife edge. Coatings of uniform thickness are readily acquired in the general sense, but they may contain a uniform ripple or "orange peel" effect. If relatively inaccessible internal surfaces are involved, naturally a lesser degree of uniformity of thickness is secured.

The electrical properties of polythene render these sprayed coatings an attractive proposition for electrical insulation. Racks, hooks, brackets and the like which carry cable forms can be so

treated instead of wrapping them in electrical tape. Labour saving in this application is appreciable. Insulating coatings can be applied to switch handles and knobs instead of rubber coverings. The reverse side of metal panels can be treated for protection against accidental short-circuiting by contact. In the lighter electrical communication industries, metal covers are used as magnetic or electrical shields, or as dust covers. Often they have to be insulated electrically on their inside surfaces to prevent short-circuiting between conductors on the covered apparatus, such shorting being possible by direct contact due to errors in dimensions or for other reasons, or by excessively close proximity. Long-established practices include the cementing of insulating liners of material such as thin vulcanized fibre, varnished cotton or silk cambric, cellulose-acetate film, etc. They carry with them problems of finding suitable cements or adhesives, difficulties in ensuring sound fixing when using quick methods, and always lines of weakness at junctions, particularly those between the end and sides of a cover. Fig. 6 shows these lines of electrical weakness in the cemented liner of a tubular metal cover, while Fig. 6a demonstrates the continuous type of coating obtainable with sprayed polythene. Polythene spray is really attractive in such applications, not only because of assured electrical properties of insulation resistance and breakdown voltage, and immunity from deterioration under damp conditions, but also on account of ease of application and inexpensiveness. The tools required for cutting insulating material to size, and jigs for its fixing, are eliminated, and the work can be quickly executed as a normal metal-finishing operation at a predetermined rate.

Fig. 6 (left).—Metal cover, inside insulated with liner, fixed with adhesive, peripheral junction around base at A, side seam at B.



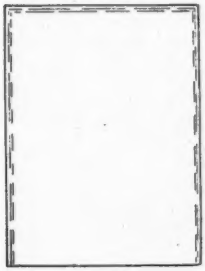


Fig. 6a (right).—Metal cover, inside insulated with sprayed polythene coating, no break in surface, no seams or junctions.

Another specialized application for sprayed polythene is based upon its properties of water-proofness and impermeability to moisture vapour. In consequence, sprayed polythene coatings can be used with advantage on the inside surfaces of cast boxes, or of those built up by flame welding. Particularly is this so for such built-up assemblies having many junctions as from windows, bushes, tubular fittings, etc. The flame welds can

be porous, especially if any of the junctions are difficult of access by the welder. On heavy iron work, properly cleaned, of course, a protective finish of sprayed zinc may first be applied if desired, and the surfaces can be warmed with the flame gun before closing the orifice to pick up the polythene powder. Further, a sufficient thickness can be applied to ensure continuity, and this can be sealed with the flame gun in order to guarantee no porosity such as that which is encountered with metal sprayed coatings.

The merits of sprayed polythene coatings for this type of waterproofing, or for combined waterproofing and electrical purposes, should not be overlooked. The attention of technicians troubled with marine or jungle conditions is particularly directed to this type of finish. Further, by developing simple heating devices, such "boxes" can be completely sealed against the ingress of dampness by taking advantage of the polythene coating extended over the seating between box and lid.

The synthetic rubber-like material Thiokol is another of the synthetic plastics for which the flame-gun technique has been developed for sprayed coatings. Here again, the spray film exhibits the properties of the plastic material and shows no evidence of decomposition due to passage through the flame gun. In particular, no sulphurous acids, as might be expected from this high sulphur content material, can be detected in the film. Resistance to chemical fumes is one of the outstanding attributes of Thiokol, and sprayed coatings on heavy section steelwork are used for this reason, for example, for protection from combustion products, flue gases, etc.

A specimen of Thiokol sprayed steel, the latter being $\frac{1}{8}$ in. thick, one surface only covered with the coating, and with the edges bare, was exposed to a salt spray test for six months. The test consisted in subjecting the sample to the mist formed by atomizing 20 per cent. salt solution with compressed air at ordinary temperatures. The spray was operated during an eight-hour day, the specimen being left in the mist-laden cabinet for the remainder of the 24 hours, except for removal for examination. During the latter, it was rinsed in cold running water and dried on a soft cloth.

At the end of the six-months period the rusting that developed on the edges had progressed inwards under the Thiokol coating but only for a depth of about $\frac{3}{16}$ in. No attack whatsoever was evident beneath the coating. Thus the Thiokol layer had given complete protection, and itself had not deteriorated. It was still hard and passed the scratch test for adhesion. This test consisted in drawing a tapered tool having a flat end of about $\frac{1}{16}$ in. diameter vertically across the surface in a manner to just cut through to the base metal. Two or three of these scratches were made at an angle to one another, and there was no indication of the coating flaking away or giving rough edges. On the other hand, the coating was not sufficiently flexible to withstand the test piece being bent around a radius equal to its own thickness. The coating cracked and detached itself. The same result in this direction was found before and after salt spray test, so that this represents no indication of deterioration.

When completely immersed in 10 per cent. hydrochloric acid at room temperature for a period of four hours, a similar specimen underwent no change except for a slight evolution of hydrogen at the bare iron surfaces. The Thiokol coating itself was unaffected.

There is possibly some slight chemical action between the iron or steel base material and the Thiokol, during its application, with the formation of a thin film of sulphide bonding the steel to the plastic. This is somewhat akin to the normal vulcanized rubber bond, either to brass or to brass-plated steel, in which excellent adhesion results from the chemical bonding.

These tests, although of very restricted scope, indicate that on heavy work excellent resistance to moisture, chemical fumes or solutions is to be expected from Thiokol coatings, and that permanent

adhesion will be secured on heavier gauges of metal. On very thin thicknesses, consideration must be given to the possibility of vibration or flexing under service conditions, and to whether adhesion is likely to suffer to any material extent by virtue of the resultant mechanical strains.

Thermosetting synthetic resins of the bakelite or phenol formaldehyde type can be sprayed through the flame gun, and cured coatings obtained. The correct technique for fully cured coatings has to be developed, and the work is in its infancy as yet. The coatings exhibit the properties of the material, namely, good chemical resistance, high electric strength, and moisture proofness. On the other hand, the brittle nature of these resins must be borne in mind, and therefore again consideration must be given to adhesion under conditions of flexing or impact. Undoubtedly, suitable thermosetting phenolic resin powders having suitable plasticizing agents and pigments or extenders can be evolved to satisfy numerous demands.

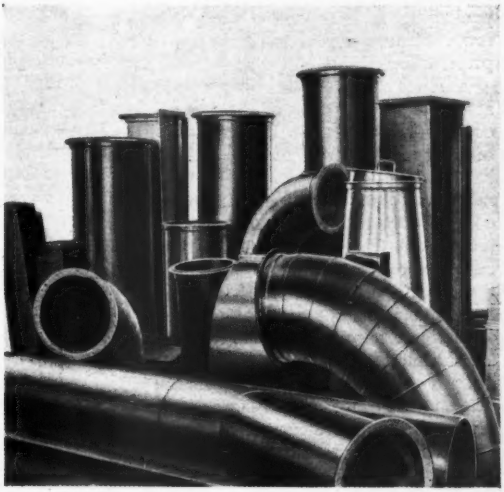


Fig. 7.—Variety of work sprayed with synthetic rubber.

Shellac and shellac base compounds can be prepared in suitable form for flame gun spray. Adherent coatings of neat appearance are obtained. An asbestos shellac compound is used when temperature resistance superior to that afforded by shellac itself is required. A mica shellac mixture is employed when high electric strength is the criterion sought.

Rubber-sulphur mixes can be sprayed to yield ebonite-like coatings having resistance to chemical fumes and corrosive solutions, provided excessive temperatures are not to be encountered. These rubber coatings can be used where rubber-lined tanks, hoods, fans and ducts are normally exploited.

Fig. 7 shows a variety of work sprayed with synthetic rubber by the Schori process, being one of the productions of Schori Metallising Process, Ltd. Equipment of this type finds application in plant for metal finishing processes, anodizing, electroplating, chemical colouring, and in the chemical industries generally.

Spray and dip plastic coatings are being employed in America to solve the difficult problem of providing complete protection to services stores, that is, equipment, plant, components, replacements, etc., during shipment overseas to the battle areas. (Ref. H. A. Knight, Metals and Alloys, " Protection of Steel Parts for Overseas Shipment," pp. 934-940, No. 4, Vol. 20, October, 1944). Conditions of hot and cold, wet and dry, sea spray or even sea immersion, sun, jungle conditions and the like have to be withstood for extended periods with-

Table 2.—Moisture Vapour Penetration of Vinylite Resin Coatings.

Number of coats	Thickness of coating, inches	Weight of water vapour transmitted through 100 sq. ins. in 24 hours, expressed in grams.
2	0.003	0.47
3	0.0045	0.29
—	0.006	0.18
U.S. specification max.		0.25

out any deterioration whatsoever. Further, plastics are helping in this direction additionally by quicker packaging and less plant. This problem of tropical packaging is a separate subject, but a few instances can be cited as apt to the present topic.

America is now shipping completely assembled aeroplanes as deck cargo on ocean-going freighters by encasing them in a specially formulated vinylite resin base plastic, which is applied by spray methods. Small openings are first covered by means of heavy tape and larger ones with wooden fillets. The entire aeroplane is then sprayed with three coats of the vinylite plastic. Two men take less than an hour for finishing a complete aeroplane. The applied film is continuous and comprises a tailor-made pattern which completely protects the job. The plastic composition is designed to give a film which flexes without cracking and which does not embrittle with exposure to the sun or wind, to rain or sea spray, or to temperature changes from hot to cold. No solvents are necessary for its removal, which can be achieved easily by slitting and peeling, a quicker operation than cleaning down oil or wax coatings. Three to four man-hours are required for this work against about 250 for the removal of grease-type rust preventers. Again, the scrap is salvaged and worked up again for re-application.

Regarding resistance to the passage of moisture vapour, the values in Table 2 are for several coats. They are reproduced graphically in Fig. 8 and they show that the material can be classified as moisture proof as well as merely waterproof. The moisture vapour pressure gradient under which these figures were determined is not stated in the original, but apparently they meet the U.S. Army and Navy Specification requirement of 0.25 grams of water transmitted through 100 sq. ins. of surface area in 24 hours under a moisture vapour pressure differential of 42 mm. of mercury at 100 degrees F.

For dipping processes, the Dow Chemical Co. supply a suitable plastic, and the Japan Co. a somewhat similar material having an ethyl-cellulose base. Suitable for plain steel, unfinished components, it is applied to such items as gears and crankshafts. The material is melted in an indirectly heated tank, controlled in temperature, the operating range being from 325 degrees to 375 degrees F. A double dip can be applied, thus treating the article first one way up and then the other; it is ensured that the two coatings overlap. A tough, tenacious coating having water- and moisture-proof properties is claimed. Removal of the coating is simple, being only a matter of slitting and peeling. Much labour is saved because no further

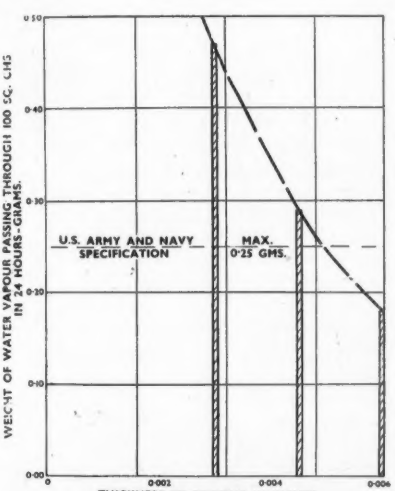


Fig. 8.—Moisture vapour penetration of vinylite.

wrapping is necessary, only boxing or crating. In contrast with this, grease-protected components have to be carefully wrapped in greaseproof paper, then in a dry wrap, and finally wax dipped. A labour saving of 60 to 95 per cent. is claimed.

The rapidity with which American technicians have solved these problems, and commercialized their results, and modified the vinylite resins and ethyl cellulose to suit the purpose is exceptionally creditable.

It will have been appreciated that the sprayed and dipped plastic coatings referred to in the foregoing can cater for a number of specific fields, and that in the broad sense they do not substitute the normal paint, varnish, enamel or lacquer coatings as applied from the orthodox solvent-containing media. The coatings are thicker, something of the order of 0.008-in. film thickness being the lower limit, and layers of $\frac{1}{16}$ in., $\frac{1}{8}$ in., or even greater, being readily obtainable. Again, the same smoothness of coating is not usually obtainable as with the organic media by direct spray. Thus, the new methods complement established processes rather than substituting or replacing them.

Possibilities of Solventless Paints and Varnishes

The development of solventless paints, varnishes, lacquers and enamel in liquid condition, ready for spray or dip application, capable of application by existing methods, and air drying or stoving to give films identical with those of the finishes applied to automobiles, refrigerators, radio cabinets, in fact to metal and to wood work in general, is a proposition different from the one underlying the present subject. The availability commercially of such media is looked for by the engineering industries in general with enthusiasm, and the probability is that they will appear at not too far distant a date. In fact, as far as varnishes are concerned, the conception is by no means new. In the November, 1944, issue of "Plastics," reference was made to the establishment of such media for electrical purposes, especially for coil impregnation, by The Westinghouse Co. of America. These materials will be referred to in a later section of this article.

Importance of Suitability of Application

At this stage it is stressed that the sprayed plastic coatings should only be contemplated for purposes for which they are apt, for which the thickness of coating chosen and the properties afforded by the plastic itself, render the process suitable. Economics must not be overlooked, because obviously the quantity of raw material consumed can be considerable. The cost of this may be small for a material such as bitumen, but it may be appreciable for plastics such as polythene, ethyl cellulose, thiokol, etc.

Again, the correct technique of application must be acquired, instituted and maintained by proper process control. For spray, this refers to gun maintenance, oxygen and propagas pressures, and air pressure, and purchase of the correct grade of raw material. For dip processes it involves correct dip temperature with indirect heating and avoidance of overheating. Failure to secure optimum results must be analysed to determine if the right conditions have been employed, if the article is held or jigged correctly, or even if the design is appropriate to the process. In illustration of this, one failure when using polythene, upon investigation showed indifferent adhesion of the polythene to the metal surface, a lumpy film and generally uneven coating. Examination gave indications that an unsuitable grade of polythene had been employed, too coarse in fact, that in consequence it had not become sufficiently plastic during spraying, and that in effect the coating had been applied too cool. This example is quoted solely to emphasize that (simple as these processes are, and in fact they are almost foolproof) if instructions are followed, the usual full attention must be given to engineering and planning aspects, as well as to process control matters.

(To be continued)

PLASTICS in the TOY TRADE

by HILARY F. PAGE, Toymaker

Author of "Playtime in the First Five Years," "Toys in Wartime," etc., and Designer of the Well-known Educational Toys Made in England by Kiddicraft, Ltd., and British Plastic Toys, Ltd., and in the United States by Childhood Interests Inc.

ALMOST every toy manufacturer I have spoken to in the past four years, both in Britain and the United States, is talking about the number of his toys which he can make in plastics after the war. The plastics industry does, in fact, present all sorts of possibilities for him, but there are limited uses which are not yet readily understood by those who contemplate entering the plastics field for the first time.

I introduced plastics into my companies in 1937. The change-over was a time of troubles, disappointments and of expense, but which finally adjusted itself as we began to understand the new materials more fully and when we started to design with these materials in view, rather than to try to adapt our existing toys to them.

My own particular toys all come into one category. They are psychologically sound educational toys designed to help and teach the child as well as to amuse him. We cater for a baby from six months up to the time he is five or six years old. One of our greatest problems, in working in wood, was to find a paint or enamel which could not be sucked or gnawed off, since almost every toy you give to a young child goes straight to its mouth. We were never successful in this quest. In plastics we found self-coloured materials which had absolutely fast colours, and, therefore, were very desirable for our types of toys.

In designing toys, in wood or metal, a certain amount of experimenting is possible. Tools which are not quite right can be altered. Different types of materials and finishes can be used. In contradistinction, one of the greatest hazards in working in plastics is that once a mould is made it is almost impossible to alter it. A mould designed for injection moulding normally cannot be used for thermosetting plastics, and thermoplastics (in their present forms) are far from suitable for all types of toys. The toy will soften and lose its shape if left in front of a fire or out in a hot sun. It cannot be washed in hot water. Mothers are most anxious to be able to wash the playthings of their babies, and usually very necessarily. Thermoplastics, moulded with too-thin sections are liable to warp and lose their shape, even under quite normal conditions. All these points, and many others, must be taken

very carefully into consideration before the mould is made at all, otherwise a heavy money loss is almost sure to result.

The American firm who had the next stand to me at the New York Toy Fair in 1941 had spent over $5,000 on multiple moulds to produce a new plastic toy. The moulds were made, and the first samples off the moulds were ready one day before the Fair opened. The toy would not work. They fiddled with the moulds, unsuccessfully, all through the Fair, and they sold practically nothing, although they had expected to do thousands of dollars' worth of business with this new toy. Nothing could be done with the existing moulds, and, finally, they had to scrap them altogether, write off the cost completely, and start all over again. They called in a competent plastics engineer-designer, and they were successful six months later. In the meantime they had lost a great deal of money on useless moulds, they had lost a whole year's trade on the toy, to which they had given a big advertising build-up before the Fair.

A careful survey of the British and American toy trades has shown me that about one-half of the toys which have appeared in plastics have been either useless or unsatisfactory—not because plastics, in general, are not suitable for them, but because the moulds have been wrongly designed, or the wrong type of material has been used.

A beautiful model of a saloon car was produced in the United States. It looked a lovely, clean toy, with far more detail than could have been put in if it had been made of wood. If a child put the slightest pressure on it in running it along the floor it was almost certain to crack. If a really good plastics designer had been consulted when this toy was being designed he would have foreseen this possibility and would have put in reinforcements in the weak parts.

The first point for a toy manufacturer to consider is the cost. Moulded plastics will only prove a paying proposition if you can be certain that your design is good and that the toy will sell in large enough quantities, in its first form, to work off the heavy mould costs. Secondly, you must weigh up the cost of plastics in comparison with other materials in which the toy might be constructed. Even though the materials may come down considerably in price after the war, they can never hope to compete with wood. An ordinary child's building-cube made of wood will always outsell one made in plastics, for the operations of making the former type are simple. The cube is cut off to length, barrelled to smooth off the corners, barrelled again with a paint or a stain and wax to polish it, and the cube is ready for marketing. A solid cube in any plastic material would cost far more. It might look and feel more attractive, but at three times the price it would not sell.

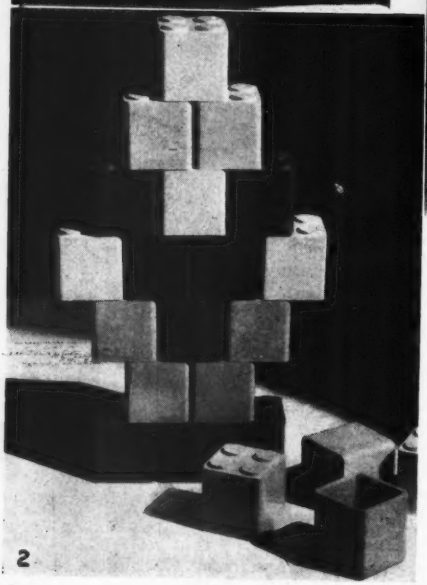
One of my most costly early experiences resulted from trying to overcome this difficulty. I found that plastic teething beads would cost so much more than enamelled wooden ones that they would be unable to compete. I therefore

Building beakers in "Mouldrite" urea-formaldehyde resin.

PLASTICS FOR T

Those who understand plastics—t mou or transparency, the inertness, t flex power, the ability to broaden gr tly t

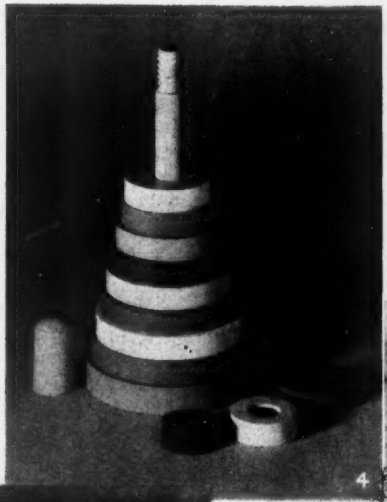
The photographs show exclusive designs by H unscrewing toy (urea). Fig. 2.—Interlocking building rings (urea). Fig. 5.—Posting box (urea). Fig Fig. 7.—"Sensible" rattle. (Moulders of urea resins

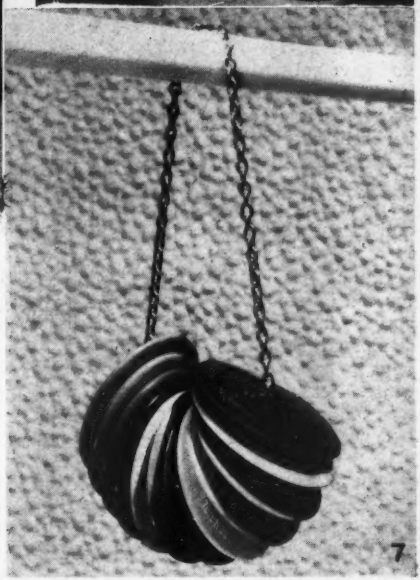


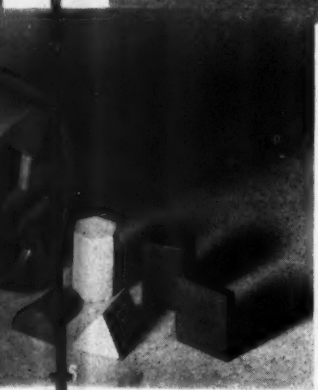
R TOYS

ics—the moulding of them, the brilliancy of colour ess, the flexibility to design—have within their en greatly the plans of this fascinating industry.

lesigns by Hilary Page:—Fig. 1.—Screwing and cking building cubes (urea). Figs. 3 and 4.—Pyramid (urea). Fig. 6.—Sand moulds (cellulose acetate). of urea resins will recognize the origin of this toy.)







designed a mould that would make coloured plastic beads in urea formaldehyde with a wooden core to save material. The mould was constructed with a small pin in each cavity. Before the moulding powder was put into the mould a wooden core was placed on each pin. The bead was then moulded with a wooden centre, and looked just as attractive as a solid plastic bead. The toy was marketed for a while at a reasonable price. Trouble soon started when these beads began coming back with large cracks right down them. If the beads were sucked by the child or were washed or allowed to get at all wet, the wooden core swelled and cracked the plastic shell. From then onwards that mould was useless.

Some articles, or parts of articles, can be moulded in plastics far more cheaply than they could be produced in any other material. One great advantage is that if you have got perfect moulds you can be certain that every article produced from it will be absolutely perfect. It will need the minimum of finishing, or no finishing at all; it will be perfect in size and fit and every piece will be completely uniform.

Having decided that our toy can be made in plastics and sell in competition with similar articles made from other materials, we then have to decide what system we are going to use and what type of material we are going to work in. I have recently designed two post-war toys, both of which will be plastic. One will be injection moulded from cellulose acetate and should be perfectly satisfactory. The other would be most unsatisfactory if it were made in anything but a thermosetting plastic.

"Billie and His Seven Barrels." A brilliant seven-colour design in urea plastics. The upper barrels all fit into the largest one.

Up to now, plastics have mostly been used in the British toy trade for "teething"-type toys—rattles, rings, discs, beads, etc. The most satisfactory material has proved to be urea formaldehyde, compressed moulded. It is non-inflammable; will stand washing in hot water for short periods; it does not soften in front of a fire or if left in strong sunlight; it is reasonably light in weight; it is reasonably strong and not liable to crack or break if moulded in sufficiently thick sections; colour range is good and it is pleasant to the feel and touch. The prices of both the paper-filled and the wood-filled are reasonable.

Fabricated parts, made from extruded or cast rods, tubes and special shapes, have also been used quite extensively and quite successfully. These cast resins tend to lose their colour and become faded very easily if exposed in a shop window or elsewhere, often making an article very difficult to sell as a result. Mould costs, apart from arbors for special shapes, are saved in working by this method, but designs are necessarily limited and finishing may prove an expensive process. Injection moulding will nearly always offer the cheapest mouldings, but careful consideration must be given to decide whether parts made in this way are going to be suitable for the purpose for which they are required.

Generally speaking, the toy trade have special problems to deal with. All their products are used by children, who will nearly always give them hard wear and treat them roughly. At the moment, mothers look upon plastics as the ideal

(Continued on page 29)

World's Industry Employs Plastics

AIRCRAFT

The British trainer, Proctor IV, built chiefly of wood and plastics, is described in detail by Bourdon in "Automotive and Aviation Industries," 1944/91/24. **"Foamax"** brand foamed rubber can now be produced from synthetic latex, according to a process developed by Firestone. The material compares favourably with that obtained from the natural material and its tensile strength is said to be equal to, or even greater than, that of the latter. The material remains flexible at temperatures as low as −40 degrees F.

GENERAL ENGINEERING

New adhesive "Pliastic" is compounded of selected resin bases together with complex non-resin materials to yield a tough, pliable continuous film suitable for the jointing of various materials. It is in the nature of a cement and may be employed in various weights to suit special needs. **New neoprene industrial glove** is produced in thin grades to give greater finger-tip sensitivity. It is provided with a non-slip finish for easy gripping of greasy objects. **Splash curtains** designed to protect machine operators and to keep floor areas clean are made of transparent sheets of Compar, a flexible rubber-like synthetic developed by Resistoflex Corporation. ("Scientific American," 1944/171/176.) **Fatigue properties of coldsetting urea formaldehyde adhesives** are described by Dietz and Grinsfelder in Trans. A.S.M.E., 1944/66/442. The authors discuss the results of their investigations with special reference to the type of joint examined, the nature of the filler and the magnitude and amplitude of stresses.

ELECTRICAL

Rubber free from electrostatic pick-up has been developed by the Goodyear Co. with special attention to the needs of munitions production and use in connection with anæsthetics in hospitals. **"Cell-tite"** is a black, cellular, rubber-base material possessing a high strength/weight ratio. It is said to have greater buoyancy and lower water absorption than cork and to exhibit excellent insulating properties against heat, sound and electricity. **Metaplast Co., New York,** has developed a new process of moulding commutators with moulded-in grooves, which are subsequently provided with the necessary metal inserts by electrodeposition. Alternatively, the grooves may be machined and afterwards metal filled by electrodeposition.

MISCELLANEOUS

Study of mechanical properties of combined laminates of wood with textile or paper was presented by Delmonte at the semi-annual meeting of the A.S.M.E. (Trans. A.S.M.E. 1944/66/55). Combination with a reasonably large number of paper laminates appears to

increase the tensile properties of wood, this result being attributed to prestressing of the wood owing to differences in thermal contraction as parts are cooled after removal from the press. Dimensional stability of plywood faced with phenolic resin impregnated cloth or paper is found to be far superior to that in unprotected plywood. **Résumé of various types of synthetic rubber** produced in U.S.A. is presented in "Scientific American," 1943/169/115. Data on composition properties and nature of raw materials used are tabulated. **New hot gluing technique** developed by Gallway makes use of adhesive based on a synthetic resin compounded with acetylene black. When a current is transmitted through the adhesive the carbon filler acts as resister, producing the heat necessary to cure the resin. In hot or cold setting, synthetic resin adhesive of reasonable flow properties can be employed as the base; curing time may be reduced to a few seconds. ("Product Engineering," 1944/15/708.) **New moulding machine** developed by Chrysler Corporation is designed to handle both thermoplastic and thermosetting materials. Special features are higher production rates and greater mould charges. ("Product Engineering," 1944/15/710.) **Plasti-Goggle,** made of one sheet of clear Plexiglas, features an eye shield extending in an unbroken curve as from side to side without corners or sharp bends. It gives unrestricted vision. **New Tachometer for hand operation** has a cylindrical indicating device, produced from a plastic tube. ("Canadian Machinery," October, 1944, p. 99.) **"Lucidip"** is the name given to a dye developed for colouring acrylic resins, such as Lucite and Plexiglas. After fabrication, the component is immersed in the liquid at room temperature for five minutes or more, depending on the depth of colour wanted. Another dye evolved for colouring cellulose-acetate plastics requires an immersion period of only 1-30 seconds to obtain depths of colour ranging from lightest pastel to the nearly opaque. ("Machinery," New York, 1944/50/194.) **Chief plastic materials** are charted with explanatory notes in "Standards Review," 1941/1/12. Agreement amongst English-speaking peoples on the terms used in the plastics industry is being sought through the United Nations Standards Co - ordinating Committee. **"Quadraphone,"** a recently introduced type of dictating machine, is described in a recent issue of "Machine Design." The sapphire recording point of the instrument is mounted in a moulded Lucite holder. **Use of water-soluble phenolic-resin adhesives** in place of alcohol-soluble adhesive films has resulted in considerable advancement in the technique of production of laminated and compressed woods, according to H. Benz in "V.D.I. Zeitschrift," 1944/88/197. The use of aqueous in place of non-aqueous solution has resulted in considerable improvement in technical properties. **V.D.I. 2024,** referring to plastics designed for subjection to special climatic conditions, was recently referred to in "V.D.I. Zeitschrift," 1944/88/184. The effects of climate on plastics and the nature of the stresses arising as a result of temperature variations, high humidity and radiated heat are dealt with. Recommendations are put forward as to the selection of suitable resins and fillers by means of which the adverse effects of climate may largely be counterbalanced. **Standards Sheet 53893 of the Plastics Committee of the V.D.I.** proposes uniform test temperatures for plastics. In the range − 80 degrees C. to + 250 degrees C. twenty different testing temperatures have been fixed, which should be observed for routine purposes. **Methods for determination of water** used in various industries have been investigated by Feith to determine their applicability for the estimation of water in plastics. Feith has developed a special method for this purpose. ("Kunststoffe," 1944/34/71.) **Cohesion between the single layers of laminated plastics** may be determined by a simple device developed by Weigel, described in "Kunststoffe," 1944/Vol. 34. **Contents of V.D.I. 2008,** dealing with forming of vinyl resins, are discussed by Romer in "Kunststoffe," 1944/34/77.

Tolerances for Plastic Moulded Screw Threads

Reply by Mr. J. Butler to the Review Published in the December Issue of "Plastics"

MR. HALLIDAY'S article is at the same time interesting and most useful. I would say here, however, that in describing, as Mr. Halliday has, the purpose of the proposed scheme as threefold, it is necessary to mention the main purpose which in itself combines the other three. The purpose is this: to present eventually, via the British Plastics Federation Tolerances Sub-committee, a scheme of thread tolerances which can be accepted by the industry as a standard. To do this it is necessary to get the views of a large cross-section of the engineering industry, particularly those interested in plastics.

The views expressed in the proposed scheme are my own and some of my colleagues, guided somewhat by the fact that I have had the opportunity of obtaining relevant views of Mr. Freund, of E. K. Cole, Ltd., and Mr. Harrison, of Witton Moulded Insulation Works, G.E.C., who are co-members of the Tolerances Sub-committee. Mr. Freund, in particular, has been of great help already in the matter of expert comment and criticism of the early draft of the scheme; his reading of my previous draft led him to suggest a method of grouping the subjects, which I have used. The value in Mr. Halliday's article is that it is another point of view ably expressed, and will be of great assistance to industry and the Federation.

I would like to take up the points of comment and criticism in that article one by one, and answer them as I read them.

Mr. Halliday, in appreciation of the intentions written into my paper that the scheme described is provisional until mould makers are equipped to cut shrinkage compensation into a mould thread, suggests that this will be dependent:—

1. On the machine manufacturers being able to develop suitable and satisfactory machine tools for the purpose, and mainly

2. Upon the creation of a substantial demand among mould makers to render such development worth while. He suggests that that demand does not exist.

In actual fact I think the answer is this: The demand among mould makers for such machines is dependent upon the demand on them for accurate threads, a state that must, and will, arise as customers' insistence on this point increases, and as moulders, one by one, obey that insistent call. This stage has begun. Firms in the industry are to-day cutting compensation into threads on moulds. Such firms can offer accuracy in pitch; others cannot.

Among machine-tool makers, two of them have proved their ability to provide equipment for cutting compensation into threads. They may envisage a post-war market for this equipment.

Errors in Tool Making

(a) Mr. Halliday's article points out correctly the greater difficulty of obtaining close accuracy in machining threads on a split mould than on a thread contained in one mould part. His point is understood and appreciated, and a re-wording of the sentence under criticism to include the words, "or mould parts affecting their accuracy," as follows, may satisfy the point: "tool-making errors are, or should be, considerably less in making threads, or mould parts affecting their accuracy, than in making the rest of the mould."

But the point is not made that the accuracy of a split mould thread is doomed. The combination of modern

expert mould design and high-class mould-making can give results on any such thread approaching the accuracy of threads cut into one mould part. Proof of such a statement can be produced.

The point is made successfully, however, that a difference exists, and a slightly greater tolerance for split threads than for solid threads may be, I think, justified, apart from any allowance on diametric form for flash line thickness.

(b) As regards the allowance I described as meeting errors in tool-making, Mr. Halliday considers I am too generous on diameters above 1 in., believing, as he states, that a 4-in. male thread (a female mould thread) can be cut to an accuracy of .0024 in. (plus or minus .0012 in.). Internal thread grinding and up-to-date internal thread milling could do it, but ask any toolmaker if he can keep to such limits on the major diameter of an internal thread, using single-point tool screw-cutting methods on a six-impression mould. The answer by anyone who has tried it will be in the negative.

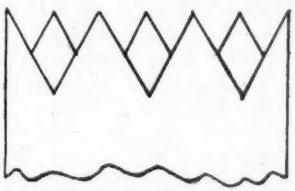
However, that answer begets another. That thread toolmakers must, in time to come, begin to use, where possible, thread milling or grinding methods. Then a revision on the lines suggested by Mr. Halliday may be possible.

I have made no comment regarding the medium and coarse tolerances. Fine limit of accuracy was the point of contention, and the accuracy provided by the skill of the best toolmakers in a particular works will be required to obtain the fine grade of tolerances. The medium grade is for threads where strength and accuracy are not all-important. The coarse grade is set to give a handle to even the "non-utility" type of thread which just serves a purpose. One purpose such threads serve in the mould-making stage is in facilitating the training of our apprentices and lesser-grade toolmakers.

Tool Wear

Mr. Halliday holds my wisdom at fault in relating this tolerance factor as being directly proportional to circumference and diameter. He claims that the relationship should be with surface area of threads. I agree this as an important point.

But he also claims that the flank area of a coarse thread is far greater than that of a fine thread over a given length. That statement shows a wisdom, the degree of which can be proved by Euclid, thus:—



Moreover, the difference in effective diameters gives to the smaller thread the larger total surface of flank. I am afraid this reverses the theory put forward by Mr. Halliday. But as I do not want to talk myself into agreeing with his main contention by proving the reverse of his claim to be true, I will submit only that the flank area of a fine thread is, to all intents and purposes, the same as, even if only slightly greater than, that of a coarse thread.

As regards the cause of wear, Mr. Halliday is correct that wear can be due to:—

1. Sluggish flow of material.
2. Excessive heat or pressure.
3. Bad surface finish of mould cavity, "and so on."

I feel one ought to discountenance points 2 and 3. The scheme is not intended to provide allowances for shoddy work or supervision, and these items come under that heading. Mr. Halliday would not have me be over-generous to an inefficient moulding foreman, and yet at the same time be hyper-critical to a skilled toolmaker in the limits he would have me allow for the major diameter of a 4-in. internal mould thread.

In any case, the path of reasoning along which I follow your correspondent's argument, Mr. Editor, comes to a stop when I read that my allowance, which I am being persuaded is too niggardly in the moulding shop, becomes in Mr. Halliday's

next paragraph "excessive on large diameters." The argument in the remainder of the paragraph is answered by me earlier in this article.

Powder Fluctuations

Mr. Halliday's contention here is that this item is much less controllable than I claimed, because (a) to leave a moulding too long in a mould will cause unequal shrinkage and distortion. (b) Delay in withdrawing a thread coring pin may lead to mal-formed or distorted threads.

I agree with these points and also with the statement that "these operational factors need consideration." They do, but surely in the moulding shop and not in a tolerance scheme, if such factors are avoidable, of which I am convinced.

In the aggregate, combining all the factors discussed, Mr. Halliday is of the opinion that my allowances are too fine, more so on large diameters. I accept this as a criticism worth every consideration, and careful thought will be given to this opinion.

Component Distortion

In general I have viewed distortion in this way: Where fine tolerances are to be used, accuracy of a degree which can permit of only the slightest distortion is implied. Where correct tool design and fixtures and/or safeguards offered by insisting on homogeneous cross-section fail to achieve the purpose, medium tolerances would be used. The latter should cover all but the worst cases. Coarse tolerances can look after the rest.

Lastly, Mr. Halliday is worried over the fact that a mould maker can no longer use standard thread gauges. I think that is unimportant for the reason that he cannot use standard gauges now for either the male or female type because of his diametrical allowances. If he needs such gauges he will make them whether he is adjusting his pitch or not. His only worry is the measurement of pitch and form, and thread comparators or projectors can overcome that difficulty.

We should think rather of the moulder who for years has had to produce mouldings with threads having a non-standard pitch, preventing him using standard thread gauges. He sees in the future a chance to use these standard gauges if he gets co-operation from the mould maker. Mr. Halliday would not wish to prevent that anticipation becoming fact.

In general and in staid vein, Mr. Halliday's article is of immense value. It gives us another point of view and has allowed me to dwell a little more on detail points. It will also help, I hope, in inducing other people to add their views, a feature earnestly desired. It is the intention to submit all criticisms received to the Technical Committee of the British Plastics Federation. J. BUTLER.

Expansion of Plastics

Mr. C. F. Merriam has contributed some interesting notes regarding the future of the industry in a recent issue of the "Financial News." While he warns his readers that unless the public is instructed in plastics it may be tempted to invest in unsound projects, yet he expects an increase in production and a wider use of the materials.

Most significant has been the urgent military demands, the shortage of metals having stimulated the use of plastics for purposes not thought of prior to the war. This cannot fail to increase the use in the future, but until the newer plastics, and the materials with which they compete, have found their economic level after the war, the promise of any plastics is uncertain, nor is it yet clear which plastics will make most progress.

Mr. Merriam believes that the outstanding expansion will be in the field of thermoplastic materials, one of the most interesting of which is nylon. Many other plastics are being made available in sheet or filament form for textiles and upholstery. P.V.C. has been greatly developed for cables, floor covering, curtains, raincoats, etc.

In conclusion, Mr. Merriam presumes that the greatest progress will be made in those countries where the chemical, coal and oil industries are most fully developed.

THE CHEMICAL CONTROLS

A Précis of the Eighth Report from the Select Committee on National Expenditure

THIS Committee is appointed to examine expenditure of money for the Defence Services, etc., and have issued the following report on Chemical Controls:—

The five chemical controls: Sulphuric Acid, Fertilizers, Industrial Ammonia, Molasses and Industrial Alcohol, and Plastics form a group with the 29 Raw Material Controls administered by the Ministry of Supply.

The Controls are concerned with every kind of action which the Department may be required to take to ensure supplies and their proper distribution and use. In addition to a general supervision of the trade or industry with which it deals, a Control may initiate arrangements for any or all of the following purposes:—

(a) The importation of supplies from abroad.

(b) The provision of new capacity in this country.

(c) The distribution of materials to the manufacturers or users, including the provision of special road and rail vehicles therefor.

(d) The rationing of supplies to manufacturers and users.

(e) Directing the purposes for which materials may be used.

(f) Fixing the price of materials.

With the burden of work considerably diminished, the Committee recommend that the whole organization of the Chemical Controls should be reviewed and consideration given to the advantages of absorbing them into the headquarters of the Raw Materials Department.

Criticism of the Controls

In the main, criticism has been of the vague kind, which is content to imply that, because the staff of the Controls have been recruited from the trades and industries they now control, they must have been influenced in their actions by their business connections. Very little weight can attach to such broad generalizations. Much of this criticism arises from ignorance of the true position of the Controls. The Committee has, however, received a number of specific allegations, mainly regarding the operation of one or two Controls.

Criticism falls under four heads:—

(i) That existing capacity has not been fully used.

(ii) That new capacity has not been distributed to the greatest advantage.

(iii) That technical and research facilities have not been sufficiently drawn upon.

(iv) That attempts to concentrate the paint industry have not been carried out.

Use of Existing Capacity

The Committee has found that there were good reasons on grounds of supply policy for the apparent neglect of the capacity in question. Sometimes the explanation is simply that, because of shipping space, it was preferable to import material at a later stage of manufacture rather than to process here from a bulkier, basic material. Sometimes shortage of a raw material explained why using departments were discouraged from ordering some products in favour of others which do not require a raw material in short supply.

The Committee consider that the situation has not always been made clear to manufacturers and that satisfactory explanation should often be possible to those who complain of neglect of their capacity.

Distribution of New Capacity to Firms

Where new capacity has been required for the manufacture of a product which has been the monopoly of one firm, the Department has given the whole of the new capacity to that same firm. With this policy the Committee agrees, unless the product is still far from being perfectly developed, when it becomes a question whether it is wise to entrust its manufacture to a single firm.

The Committee here has in mind the manufacture of polymethyl methacrylate, known in this country as " Perspex," which is the monopoly of one firm, to which was given the whole of the additional capacity for expansion.

The doubt about the wisdom of this decision arises because development of Perspex has been a difficult process and it has not a desirable strength. The Committee consider that faster progress might have been made if other firms with a fresh approach had been brought in. One firm had full qualifications for the task, but was not asked to help.

Allocation of Contracts for Research, etc.

More than half the research contracts has gone to one chemical company and its associates, yet one of the leading firms in the field of organic chemistry has not received a single contract. The explanation offered by the Director of Scientific Research, Ministry of Supply, was that the latter firm was suspicious and would not provide information of its facilities for research.

Concentration of the Paint Industry

After an abortive attempt in 1942 to concentrate the paint and varnish industries by forming " nucleus " firms and to close others, the scheme was abandoned. A fresh attempt was made in 1943, and finally two lists containing 187 works were included in the scheme, those on list (1) were firms engaged on vital products and received a higher degree of protection for some categories of female workers than those on list (2). Again protests were made by excluded firms, with the result that no small firm has actually been closed. The Committee considers that the system is unfair, since the small firms were discriminated against in regard to protection of their labour and to their obtaining of Government orders.

The Committee recommends that the lists be abandoned.

PLASTICS IN THE TOY TRADE

(Continued from p. 22).

material for the toys for their young children, but if they are going to find from experience that these toys break very easily that view can rapidly change. A responsibility rests on the moulder to advise an intending customer of these probable future snags and difficulties, but many moulders (particularly the new ones after the war) have not had the necessary practical experience of seeing these articles in use in the nursery or in the home, and cannot be expected to realize the special problems.

The best advice I can give to toy manufacturers intending to launch into plastics for the first time after the war is to employ the services of an expert designer. This designer should be a plastics engineer, with a comprehensive knowledge of the making of moulds for compression and injection mouldings and the knowledge of all the various types of materials available, their ageing properties and special characteristics, etc. He should also have had practical experience of moulding. A designer of tools or moulds for other materials will not necessarily be a good designer of plastic moulds, nor will he necessarily understand the problems which may result from an improperly designed mould. A good designer will foresee any possible difficulties of ejection from the mould of the finished product, and he will know what thickness of section will give the necessary strength to make a good and satisfactory toy.

PROBLEMS OF CREEPING PATH IN PLASTICS

By B. FRISCHMUTH

Continuing from "Plastics" for October, 1944 (page 483), a study by Frischmuth of the electrical breakdown of plastic insulators. The author concludes that uncertainties regarding the mechanism of this process preclude, at the moment, the development of a satisfactory laboratory test.

IN the first case the component is stressed with reference to resistance to sparking, and, in the second, with reference to its resistance to a light arc. Only in the third case is a creeping path,

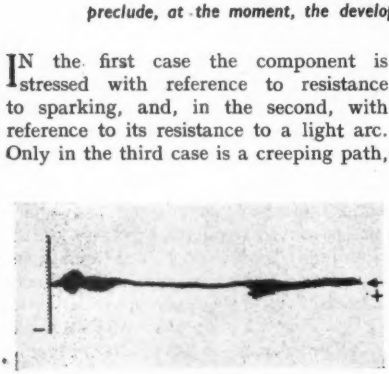


Fig. 1 (above).—Characteristics of discharge at a surface possessing uniform conductivity, the discharge ceasing after surface moisture has been dried out by the current.

Fig. 2 (right). — Characteristics of discharge at a surface exhibiting points of varying conductivity.

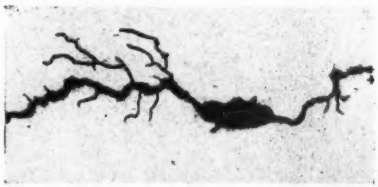
in the true sense, formed. This last case can be further subdivided—

(a) if particles that have accumulated at the surface, such as dust or debris from the wear of the material, can reduce the electrical resistance, so that an electrically conducting creeping path is formed, or

(b) if ionisable particles on the surface can, in connection with a moisture film, initiate a creeping path.

In the case of (b) we will have again an instance of thermal load, as the heat of the current will cause the electrolyte to evaporate and thus lead, indirectly, to the formation of sparks.

Von Cron subdivides possibilities of the formation of creeping paths into those without gas discharge and those with visible discharge of gas. He extends, therefore, the classification given before, according to which only type 3 would refer to the formation of a creeping path. He suggests, further, a sharp separation of the definitions of creeping path and creeping trace, and supplies a more accurate definition for creeping current. This is understood as the conduction of



current along the surface of an insulator, caused by the physical properties of this surface, such as adsorption power, structure, heat conductivity, etc., so that a current path can be formed, the electric conductivity of which is higher than that of its closest surrounding. These spots of higher conductivity are defined as forming a creeping "path."

According to the chemical properties of the material concerned, there exists, to a greater or less degree, the tendency to form a creeping "trace." This in itself is a continuous, good-conducting interval,

caused by the action of high electric load, and leaves on the surface of the insulator a permanent, visible, and measurable change, for instance, a carbonized path.

Thus it is necessary to distinguish clearly between the formation of a creeping "path" arising without direct deterioration of the insulating properties and a tendency to the formation of a creeping "trace," involving a total breakdown of the insulation. This differentiation implies recognition of the well-known fact that creep can often be observed in spite of the fact that the inherent electrical resistance of a material has not been reduced, or, if at all, to only an unimportant effect.

The new definitions are based on investigations by von Cron, using laminated

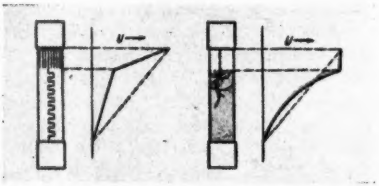


Fig. 3.—Illustrated discharge phenomena at the surface of impregnated paper. The diagram at the left shows result of slow uniform discharge with drying-out effects and without production of creep path. The diagram at right illustrates discharge at a surface showing non-uniform conductivity.

paper tubes subjected to high-tension current. He observed the formation of creeping paths due to gas discharge with an e.m.f. up to 160 kV. Two types of "path" were observed: a "line trace" caused by the discharge in spark form across the whole distance between the electrodes. This occurs mainly on dry surfaces, and the discharge is not deviated by differences of conductivity at the surface, the path being burned in as a straight line. The second type, or "point trače," is caused by a migration of the contact point of the discharge owing to the action of the electric field; thus the path becomes tortuous and branched as it adapts itself to the distribution of the electric field. This type is characteristic of moist surfaces.

For the formation and shape of the creeping path, therefore, the electric field is of decisive importance. If, in the case of a uniformly conducting surface, the discharge be distributed over the whole area, conditions may arise where it exerts a drying action, thus the path is extended, until, with increasing resistance, the potential is no longer sufficient to maintain the flow of current., i.e., the spark is extinguished. If, however, through inhomogeneity of the field, the field strength be at any point concentrated, a point "trace" is caused; this is driven over the moist surface as a result of the electric force towards the other electrode. It may be that the non-uniform distribution of conductivity along the surface is a preliminary condition for the formation of the creeping path; the physical properties of the surface are criteria for these different behaviours.

It is difficult to decide which of the hypotheses described may correspond best to the phenomena observed. It is possible that other causes, too, may be responsible for the formation of the creeping path. In any case, it is extremely difficult to devise a set of experimental circumstances equivalent to real creeping current conditions. The great number of publications, investigations and suggestions alone show the importance of this problem in so far as it concerns the practical application of plastics for electrical purposes.

A much-used method is the drop test. Two knife edges are placed a given distance apart on the plastic sample and alternating current is passed between them. Drops of an aqueous solution are then allowed to fall successively between the edges, the time required to form a conducting path being determined. The drops can either fall at distinct intervals of time, or the next drop may be applied after the first has been evaporated by the

action of the heat of the current. The first arrangement corresponds to the regulations of the Swiss Electrotechnical Committee (S.E.V.) and the second to those of the German Electrotechnical Committee (V.D.E.).

Another system, the melting-wire method, has been used in England. A fuse wire is melted between two insulating plates, the number of repetitions of this process required to form a conducting bridge on the surface after evaporation of the wire being determined. This method, however, cannot be employed for many plastic materials owing to excessively high-temperature melting, evaporating and burning phenomena. The drop test, also, does not cover the real mechanism of the formation of creeping path as it involves a chemical reaction. Thus, for a given material, it is not permissible from these tests to draw conclusions as to safety against creeping currents. Failure of a material may be due to faults in design, which must be checked by service tests.

The drop test has the advantage that it can be reproduced in a relatively simple way, hence it has been modified to suit the requirements of plastics; in particular, the German Physikalisch-Technische Reichsanstalt has carried out very thorough investigations with a special testing device. The samples, either special test pieces or finished parts, are dipped periodically into a test solution and then subjected for one minute to alternating current at 220 volts. If the current passed by one of the samples exceeds a given value, the dipping device is automatically stopped, the number of dippings being used as a measure of the resistance to creeping-path formation.

In this way, the influence of electrodes, surface condition and temperature upon various plastics has been checked, using various solutions of sodium chloride. The data obtained show great variations for the same plastic as manufactured by different concerns. A large number of electrical devices, such as plugs, sockets, rotary and oscillating switches, have been tested by the same method. Some types had to be provided with holes in order to attain complete wetting, and to allow the solution to flow out. In this case still greater variations were observed. In spite of this, the authors suggest a classification according to the number of dippings required to produce a short circuit.

Summarizing this review, it can be said that the primary causes of the formation of creeping paths cannot be explained by physical and chemical processes alone, and that we cannot expect a test method capable of yielding reproducible results is likely to be developed.

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CORNER CUBES *(Continued from p. 5)*

that the quantities were doubled half way through the completion of the first contract.

The whole of the design work and supervision of the contract was carried out by I.C.I., who provided the "Transpex" used for the machining of the corner cubes and who completed and assembled the components.

Credits.—Of the sub-contractors, Thomas Holt, Ltd., of Rochdale, textile machinists, deserve special mention, as they prepared in record time and then operated the 15 small, specially designed milling machines. The moulds for the mountings were prepared by the Streetly Manufacturing Co., Ltd., Insulators, Ltd., and Joseph Lucas, Ltd., and the mouldings were made by the same companies and by Ashdowns, Ltd.

Moistureproof Wrappings

Testing Permeability to Moisture

By W. BERRY, M.Sc., F.R.I.C. (British Cellophane Ltd.)

THE number of film-forming materials which can be converted into moistureproof wrappings is growing rapidly, and in these days of container shortage the uses to which the wrappings are put are many and varied. Because of this enormous increase in the choice available to a manufacturer who is seeking wrappers for his product, tests have been devised to measure moisture vapour permeability. Unfortunately, it has been obvious for some time that there is a great lack of uniformity in this method of measurement, and Carson[1] published in 1937 a useful critical comparison of results from many sources.

In spite of his conclusions many papers are still published without regard to their general value, perhaps because Carson's paper was in the nature of a compilation rather than a criticism. It is not infrequent to find papers quoting tables of comparative permeabilities of various wrappings, in which the author does not fully state the conditions of his test and gives no indication of the source of the materials tested. For this reason many figures are published which are in direct contradiction to each other, and in some cases are even contrary to the dictates of reason.

It is appropriate, therefore, to reconsider the factors relevant in the measurement of moisture vapour permeability. These are enumerated by Carson as: (1) Time. (2) Area of the specimen. (3) Leakage at the edges. (4) Thickness of the specimen. (5) Vapour pressure gradient across the specimen. (6) Vapour pressure at each face of the specimen. (7) Total pressure difference across the specimen. (8) Temperature. (9) Diffusion through the air space. (10) Von Schroeder effect.

With reference to time, provided that precautions are taken to ignore the initial period of adjustment, the time should be as short as is compatible with reasonable accuracy. In many cases the tests are routine examinations of commercial material, so that the time-lag between production and evaluation should be as short as possible. When it is pointed out that in one manufacturing company nearly 100,000 measurements of permeability have been carried out in less than a decade, it will be realized that no measurements should last longer than 24 hours, and that the conditions must be chosen to give a measurable permeability within this period. Shorter periods are not advocated, since where the membrane is not homogeneous but consists of a coated base-film, the results so obtained are likely to be inaccurate if the period is less than 24 hours.

Specimen Areas and Seals

The area of the specimen is limited by the width of dish which can be accommodated by an analytical balance, and by the circumference of seal which can be adequately closed as a routine operation. Since the area varies as the square of the diameter, and the circumference varies only directly as the diameter of the dish, it is obviously desirable to use as wide a dish as possible. It is usually the balance available which limits the area of permeability, but a reasonable figure may be taken as 0.03 m.^{2}

Elaborate edge-seals are undesirable as the weight of the pot must be kept low for accurate weighing, and leakage at the edges is almost impossible to avoid by the use of gaskets, therefore the molten-wax type of seal is used where large numbers of determinations have to be made. The composition of the sealing-wax varies, but if the operator is correctly instructed and supervised adequate seals can be obtained by this method, as is shown by

a statistical analysis of a number of measurements on one piece of material.[2]

In many cases attempts have been made to correct for the thickness of the membranes,[3] but such correction is almost always unjustifiable. Some membranes are not homogeneous, and depend for their impermeability on surface coatings. Further, even where the material itself is homogeneous impermeability is not proportional to the thickness.[4] Accordingly, published figures of diffusion coefficients are of little significance.

Many alternative arrangements have been described, which give various vapour pressure differences across the specimen. In order, however, to obtain the greatest accuracy in measurements and to search out any weakness in the material, it is, without doubt, desirable to use the maximum possible moisture vapour gradients. Humidities on one side approaching 100 per cent. are obtainable by the use of distilled water, but it is not so easy to obtain low humidities. Calcium chloride, although most conveniently handled, is a notoriously bad absorbent for water and should be avoided if possible. Sulphuric acid is also inefficient, and desiccants like magnesium perchlorate are expensive for routine examinations. We have found that in the long run phosphorous pentoxide is the most convenient desiccant, although even using this it is difficult to obtain a relative humidity below 5 per cent.

Under the conditions described above, the vapour pressure gradient can only be increased by raising the temperature of test, and it is, therefore, essential to control the temperature accurately during the course of comparative experiments, and to quote the temperature at which the measurements are made.

The relative vapour pressure, as explained above, should be as great as possible under experimental circumstances. Certain materials may show unduly good results over short humidity ranges, and it is important to use conditions which do not show favour like this. Also in the interests of accuracy stringent conditions are desirable.

Temperature is the most varied factor in the measurement of permeability, and it has yet to be proved that even Carson's units for expressing permeability, in terms of the moisture vapour pressure gradient, accurately compensate for variations in temperature. Since, however, with very impermeable membranes the change in weight of the permeability cell is small, it is necessary to use as high a temperature as possible. It must be remembered that high temperatures adversely affect the permeability of some membranes, and temperatures high enough to have this effect should not be used unless they are likely to be met in practice. Having regard to the softening point of waxes used for sealing the edges, it appears that about 40 degrees C. is the highest temperature that can be conveniently used.

Barrier Effect of Air

Attempts have been made[5] to compensate for the barrier effect of a layer of air intervening between the membrane and the water which is used to maintain high relative humidity. As the depth of this air layer is always as small as possible in practice, and as the permeability of modern wrappings is comparatively low, this effect can usually be ignored without introducing any serious errors.

The Von Schroeder effect, which is the anomalous permeability shown by solid material in contact with liquid water, is avoided by eliminating such contact.

As regards experimental technique, therefore, it will be seen that many difficulties have to be overcome in working out a satisfactory test for permeability. The test which has already been described,[6] and which has been used in large numbers in routine, uses a wax to seal the membrane over the mouth of an aluminium pot containing distilled water. The area of the membrane is 0.033 m^2, and the pot is placed in a moving atmosphere dehydrated by P_2O_5. The temperature of the pot when it is sealed is so adjusted by practice that the membrane is not distended when in the cabinet, which is maintained at 39.5 degrees C. The cell is allowed to stand

Permeability of Wrappings.[7]

Film	Thickness	Resistance to aqueous penetration
Moistureproof cellulose film	0.001 in.	6.6 mb./gm./day/m²
Moistureproof cellulose film when crumpled severely	0.001 in.	2.6 mb./gm./day/m²
Heavily waxed cellulose film	0.003 in.	9.2 mb./gm./day/m²
Heavily waxed cellulose film crumpled	0.003 in.	1.4 mb./gm./day/m²
Nitrocellulose film	0.004 in.	0.4 mb./gm./day/m²
Polyethylene film	0.005 in.	0.8 mb./gm./day/m²
Plasticized PVC film	0.002 in.	0.7 mb./gm./day/m²
Rubber hydrochloride film	0.001 in.	2.0 mb./gm./day/m²
Rubber hydrochloride film when crumpled	0.001 in.	2.0 mb./gm./day/m²
Rubber hydrochloride film	0.002 in.	4.0 mb./gm./day/m²

for 20 minutes to adjust itself before weighing, and is then placed in the cabinet for 24 hours before weighing again.

Experimental Results

To afford comparative values for the permeability of different membranes, it is only necessary to quote the actual losses in weight respectively, provided that the test is carried out under otherwise similar conditions. If, however, it is desired to obtain results which can be compared with those of other workers, it is necessary to use a unit which takes into account all the variable factors. The most comprehensive unit is that of Carson,[1] which expresses the permeability as the weight in grams of water which diffuses through 1 sq. m. of a membrane in one day under a moisture vapour pressure gradient of 1 millimetre of mercury. A more recently advocated unit[7] expresses the resistance to aqueous penetration (RAP) as the millibars of moisture vapour pressure gradient which is required to drive 1 gram of moisture through a square metre of the membrane in one day. This unit shows at once the value of the wrapping as a moisture vapour barrier, since the most efficient barriers have the highest RAP. Some figures published by Oswin illustrate this point (see table above).

It will be seen that, for its thickness, moistureproof cellulose film showed the best performance, although its lead was reduced when the film was crumpled.

No figures are given to show the effect of ageing, which causes a deterioration of some films.

The resistance (RAP) of any wrapping is varied by the treatment after manufacture, and this variation must be taken into account when an estimate is being prepared of the usefulness of a moistureproof package. This estimate, however, can easily be performed provided that sufficient information is available about the contents.[2] The accurate measurement of the resistance (RAP) of the wrapping is, however, the corner-stone of any such calculation.

Thanks are expressed to British Cellophane, Ltd., for permission to publish this paper.

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THE UNITED STEEL COMPANIES, LTD., announce that their research activities are now to be unified under a single control. Mr. Frank H. Saniter, B.Sc., has been appointed Director of Research to the company, and will take up his duties early in the New Year. Mr. Frank Saniter is the son of the late Mr. E. H. Saniter, who will be remembered as having been Chief Metallurgist to the United Steel Companies, being associated with them for more than 30 years, and who was awarded the Bessemer Gold Medal in 1910.

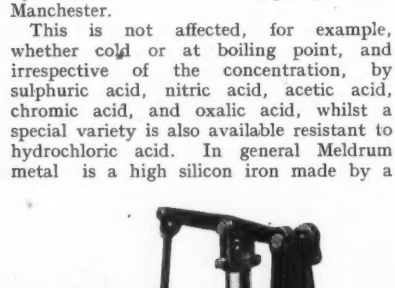
SHELLAC.—The Ministry of Supply announces that traders may now obtain from Ministry stocks certain grades of shellac for re-export to approved destinations. Further information may be obtained through the usual trade channels.

PRODUCTION NEWS

Raw Materials, New Plant, Works Organization, Control Apparatus, Research, Personal and Trade Notes

ACID PUMPS.—For the pumping of acids, acid solutions, and other strongly corrosive liquids, whether strong or dilute, and hot or cold, of great importance, and especially for the chemical and allied industries, is the use of a special metal made by Meldrums, Ltd., Timperley, near Manchester.

This is not affected, for example, whether cold or at boiling point, and irrespective of the concentration, by sulphuric acid, nitric acid, acetic acid, chromic acid, and oxalic acid, whilst a special variety is also available resistant to hydrochloric acid. In general Meldrum metal is a high silicon iron made by a



special process containing a high silicon content, and less than 0.1 per cent. phosphorus, the proportions, along with a very small amount of carbon and manganese present, being maintained with great accuracy because of the scientific methods adopted in the manufacture. This results, apart from very high resistance to acids, in the correct degree, for example, of freedom from brittleness, and hardness, together with extremely uniform structure because of the complete mixing given and the absence of impurities such as graphite.

Typical of the firm's production is a single-ram belt-driven plunger pump with a capacity up to 150 gallons per hour, whilst there is also a similar double-ram pump with belt or electric motor drive, being a neat and effective design on one baseplate. Similarly also there is a small pump of this type for hand operation, and the design is particularly suitable for operating conditions with small capacities and high pressures.

SEIZING OF NUTS AND BOLTS.—A well-known trouble is the "seizing" or "binding" of nuts, bolts and studs in chemical and steam equipment of all types, especially when subjected to a considerable temperature, so that after tightening up they can only be unscrewed again with great difficulty and in bad cases have to be cut off.

One cause may be the presence of solid impurities, such as grit, often from the oil or grease used, which on tightening result in a permanent deformation of the thread and tend to give a locking action. Another cause is chemical decomposition of the oil or grease, especially at higher temperatures, with formation of acid compounds which cause corrosion. Similarly contact with steam or water gives rusting, a common cause of the seizing of nuts and bolts. Again the oil or grease used often forms, at higher temperatures, a solid resin-like residue which acts to some extent as a cement and aggravates seizing. These considerations apply equally to pipe joints, threaded covers and other examples of the use of screw threads.

An effective remedy, however, for preventing seizing and binding is to use a dispersion of colloidal graphite in a suitable liquid, painted on the clean screw thread with a brush, sprayed, or applied in any other suitable manner, and allowed to dry before use. For this purpose one can use colloidal graphite suspended in water, known as "Aquadag," a production of E. G. Acheson, Ltd., 9 Gayfere Street, Westminster, S.W.1. A later development is to use a dispersion of the colloidal graphite in a highly volatile organic liquid, such as acetone, which enables nuts and bolts, or other parts, to be treated in batches, with very rapid drying. The result is the formation on the screw threads of a fine film of dry colloidal graphite which prevents seizing or binding in striking fashion,

even after very long periods at considerable temperature.

"BAKELITE RESINS."—This popular booklet has now been revised and made up to date. It deals with those phenolic resins, mostly in solution form, which are so widely used for the impregnation of brake linings, the impregnation of wood, the bonding of wood and the impregnation of fabrics for laminating. There is also much detail on the use of Bakelite cements for the setting of bristles, lamp-capping, etc., and on the use of Bakelite varnishes for coil impregnation, coating metals and many miscellaneous purposes. Readers may obtain copies of this excellent production by writing to Bakelite, Ltd., 18, Grosvenor Gardens, London, S.W.1.

EKCO PLASTICS EXTENSION.—Indicative of the expansion taking place in the plastics division of Messrs. E. K. Cole, Ltd., is the announcement that Mr. D. Radford has been appointed general manager of that section of the company. Mr. Radford has for some time been works manager of both the radio and plastics factories at Southend.

Mr. F. C. Pullen, another executive of the company, has many connections in the radio and plastics industries, and is appointed sales manager of the plastics division.

The Ekco plant, recently appreciably increased, was one of the first in this country to produce mouldings of large dimensions, such as radio cabinets, etc. It has more recently been greatly strengthened, both technically and commercially, and is now largely devoted to solving plastics problems allied to general engineering. The plastics division possesses a modern and well-equipped toolroom, itself expanded to meet growing commitments.

GAUGE AND TOOLMAKERS' ASSOCIATION.—At a recent meeting of the council of the association the following appointments were made for the 1944-1945 session:—Mr. H. H. Harley, C.B.E., M.I.P.E. (chairman and managing director of The Coventry Gauge and Tool Co., Ltd.), was re-elected president of the association; Mr. F. W. Halliwell, M.I.Mech.E., M.I.P.E. (chairman and managing director of Gay's (Hampton), Ltd.), was re-elected chairman of the association; Mr. H. S. Holden (managing director of The Brooke Tool Manufacturing Co., Ltd.) was re-elected vice-chairman of the association; Captain C. R. Cook (governing director of Pitter Gauge and Precision Tool Co., Ltd.) was re-elected honorary treasurer of the association. The membership of the council was increased from 15 to 19 members by the election by ballot of Mr. L. H. Barton, Mr. E. N. Hall, Mr. S. Carlton Smith and Mr. R. H. Try.

"CORNERCROFT, LTD." — At the annual general meeting, Captain W. F Strickland, chairman, gave some information regarding the post-war plans of the company. This concern, which has a large output of plastics, through its subsidiary Cornercroft (Plastics, Ltd.), will enter the field of producing prefabricated houses and will also produce new ranges of electric light fittings, domestic appliances, model engineering products and educational toys.

DE LA RUE PLASTICS, LTD.—Mr. F. C. Edwards has been appointed sales manager of De La Rue Plastics, Ltd., as from December 1, 1944.

CRYSTALATE, LTD.—The directors of Crystalate, Ltd., will submit proposals for the financial reconstruction of the company at a meeting to be called early in the New Year. Up to September 30 last, receipts were £57,170, with dividend from British Homophone at £10,200. Tax provision is £33,300 and net profit £11,385.

SOCIETY MEETINGS

SOCIETY OF CHEMICAL INDUSTRY (PLASTICS GROUP).—The Jubilee Memorial Lecture will be given on January 18 at the Royal Institution, Albemarle Street, London, W.1, by Dr. L. A. Jordan, and will be entitled "Paint—The Art and the Science."

A joint meeting of the **BRITISH RHEOLOGISTS' CLUB,** The Faraday Society and Plastics Group, will be held on Wednesday, January 24, 1945, at 2.30 p.m., in the Lecture Theatre, Institution of Mechanical Engineers, Storey's Gate, London, S.W.1, when a lecture on "The Rheology of Plastics" will be given by Dr. G. W. Scott-Blair, of the British Rheologists' Club. The chair will be taken by Prof. E. N. da C. Andrade, F.R.S. The lecture will be followed by a discussion and short contributions are invited from members of all three participating societies.

Planned Mould Maintenance Service Aids Economical Production

Part IX

By W. M. HALLIDAY

Continuing last month's discussion of injection mould features as applied to moulds required for the formation of externally or internally threaded components; with special reference to their beneficial or other effects upon mould working condition, high level of accuracy of finished plastic product, and the consequent amount of maintenance service required.

The Lateral Slide Type of Mould

THE next important type of injection mould design for producing mouldings having externally threaded portions is illustrated in the two sectioned drawings A and B, respectively, in Fig. 10, which shows a typically common representation.

This method of construction, known as the lateral slide type, is indeed one well favoured by designers, chiefly because it permits considerable simplifications being made in the ejection of the completed moulded article, and also a high rate of production. Generally with this form of construction it is possible to arrange for ejection to take place entirely automatically coincident with the normal opening movement of the movable mould block. Thus time is not absorbed in separate manual operations to effect ejection of the moulding after mould blocks have been parted, as is the case in previously mentioned mould designs, hence there is obtained a commensurate stepping-up of output.

As will be gathered from examination of the drawings this method of construction employs the principle of two opposed identically located slides which come together in such a manner as to form the requisite cavity in their contiguous faces, and these slides are capable of being withdrawn from each other so as to free the moulding after injection of the plastic material whilst slides are in their closed position.

Referring to the view A in Fig. 10, the two lateral slides are situated within the movable block; this latter being provided with suitable dovetail, or tongued guideways for the effective and accurate guidance of the movement of these slides.

The mould cavity is machined exactly

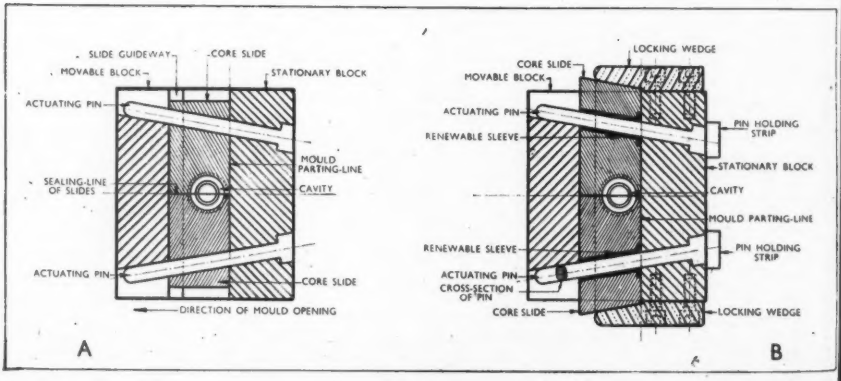


Fig. 10.

BEETLE RESINS, for instance. They bind together lots of things—sawdust, fabric, wood, pigments and so on. Sometimes they make moulded articles like electric switches, sometimes they make cardboard weatherproof and tough. They may bind a Mosquito aircraft together or appear as the bond in laminated sheets. And the bind is permanent—once the operation is performed heat or damp has no effect. There's a great future for Beetle bonding --are you interested in the future?

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half diameter in the end of each slide, so that when both slides are brought together the complete cavity is formed between them. Sealage against flashover is provided by the surrounding end-faces of each slide, which are fitted very closely together so as to preclude all escape of incoming material.

The two slides are automatically operated for opening after injection, and closing in readiness for the next cycle, by means of two actuating pins which are fixedly placed in the stationary mould block, and which extend at a suitable inclination from the parting-line edge of that member. This projecting portion passes through a hole in the lateral slide, as indicated. Thus when the movable block is withdrawn from the stationary block after injection, the inclined actuating pins cause the lateral slides to move apart, so freezing the moulded component, which usually falls out of the block into a suitable receptacle under the machine outlet chute.

Reproduction of the threaded cavity in this type of mould is rendered comparatively easy because it is possible to remove the two lateral core slides and set them up separately for machining the cavity proper. Thus the engineer or machinist is better able to watch all the machining processes, and to test for sizes, finish and thread form. All these items are often very difficult to solve satisfactorily where the threaded cavity must be cut into the mould block material direct, or is located at the bottom of a deep hole, etc.

In mouldings of considerable length and where the threaded portion is only of short length the lateral core slides would in such a case be used for forming the threaded portions alone, all the plain parts of the cavity being cut into the mould blocks in usual fashion.

This interesting type of construction, however, possesses several drawbacks when regarded from the maintenance angle. Still dealing with the type shown at A in Fig. 10, the disadvantages to be noted are as follow:—

(1) The actuating pins for determining the movement of the lateral slides must be very strong and well fixed in the stationary mould block, because if there is the slightest loosening in their fixings, or deflection due to smallness of cross-section, the lateral slides may fail to close properly, thereby causing a flashed moulding, as well as one having ovality of threaded portion.

(2) Weak or insecure actuating pins may also permit the slides to open a small amount at the instant of injection due to the great pressure behind the incoming plastic material entering the cavity. Here again undesirable size variations may occur in the finished article, as well as additional subsidiary sizing operations being necessary to correct for ovality and removal of thick flashes around the parting-line edges.

(3) After substantial use of the mould some wear will occur between the lateral slides and their guideways, and also between the actuating pins and the hole in each slide. Here again, should this develop and remain uncorrected, the slides will be forced apart at each injection "shot," with the harmful results already described. Not only may these faults arise but wear between the slides and guideways may cause a slight misalignment in the two slides when in closed position. This will entail an endwise displacement of the two halves of the mould cavity which will then produce a moulding having the two halves slightly off-set and non-matching.

(4) Unless the lateral slides themselves are made of ample strength and cross-section they may suffer distortion as a result of either heat treatment prior to use, or because of temperature and pressure variations during operation. In the case of slides weakly constructed or shaped, too sudden heating or cooling may cause serious shape variations to occur, which in turn will give rise to puzzling variations in the finished product.

(5) Yet another point worthy of close consideration in respect of this design concerns the matter of lubrication. As will be understood during normal working of such a mould, considerable areas of its surface are in sliding contact, as, for example, that between the slides and

their guides, and the actuating pins within the slides. This means there is a substantial amount of friction attendant upon operation; hence such a construction requires closer attention to and provisions for effective lubrication. If this is not done there will be an enhanced risk of binding, stiffened operation, or even complete seizure occurring between some member. With this kind of mould it is essential that the operator be correctly instructed to notice the early effects of the lack of lubrication, and also in the proper method of performing such lubrication of the various mould members.

(6) If the same material is used throughout to make the mould blocks, lateral slides and actuating pins the dangers of seizure will still further be increased; hence the intelligent designer will endeavour to avoid such troubles by stipulating that the slides be made from different materials to those used for the mould blocks and actuating pins. In addition, the existence of such increased sliding friction will require closer attention being paid to heat treatment and especially hardening and tempering operations.

(7) Another practical disadvantage which the present writer has found associated with this type of mould construction appertains to the question of cleaning. As is well known, all plastic moulds during continued operation tend to accumulate tiny particles of excess plastic material, dirt and other foreign matter, both on the parting-line surfaces and on the walls of the cavity itself. If successful moulding is to be performed such interfering particles, whether in the cavity or on parting-line surface, must be carefully removed after every few shots. Access to the cavity for such necessary cleaning purposes is apt to be somewhat restricted or difficult with the design of mould now under consideration, with the result that cleaning is often not carried out frequently enough, or in a thoroughgoing manner. Thus the maintenance engineer will find troubles arising solely because of the dirty condition of the mould members, and the neglect of the operator, who, however, may consider it some justification for his failure by pointing out the awkwardness of getting at the cavity, etc.

At B in Fig. 10 is shown a sectioned view of a somewhat improved form of design, which is to be preferred to that at A. The chief improvement consists in providing a positive closure means whereby the two opposed lateral slides are held positively in correct position during the injection stages.

This positive locking of the slides is obtained very simply, as will be noticed. To the sides of the stationary mould block are attached stiff sectioned steel locking wedges, each having a tapered portion projected over parting-line edge of stationary block sufficient to bear an

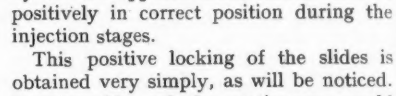


Fig. 11.

adequate distance over end of the core slide. Each slide is made long enough to allow its outside end to project over end-face of the movable block, and its end is tapered off at the same angle as the inclined side of the locking wedge bracket. When the lateral slides are in the proper sealing closed position the locking wedge brackets are so adjusted as to bring them in actual contact with the slant ends of slides as shown. Incidentally, the angle of the inclined side of the locking wedges and ends of the lateral slide should be the same as that at which the actuating pins are located.

In operation these wedges act in the following manner. As the movable mould block and lateral slides are brought towards the right for closing the mould the actuating pins first move the slides together, this being finally achieved when mould blocks are closed. The last $\frac{1}{16}$ in.

of movement of the mould blocks will cause the ends of the slides to bear against the inclined under-side of the locking wedges, which, in turn, will positively prevent any accidental opening of the slides during injection.

Such wedge brackets should be of strong material and suitably hardened, and above all very powerfully secured to the top edge of stationary block.

Should any wear develop between the actuating pins and their holes in the slides this may easily be corrected by making a slight adjustment on the locking wedges, either by slightly advancing them nearer to movable block, or by directly lowering them on ends of stationary block. Either action will ensure that sufficient binding pressure is imposed on the slides to withstand opening force arising during injection.

It will also be seen that each slide is provided with a hardened steel sleeve in the hole through which the actuating pin passes. This not only overcomes possible objections in the way of making the slide of different material to its actuating pin, but chiefly renders correction for wear more feasible. Thus in this latter case it involves no great loss of time or outlay to renew such sleeves and to restore the hole in slide to its original shape or size.

Although not illustrated on the drawing B (it being omitted for the sake of clearness), provision should be made for supplying the two lateral slides with an adjustable gib, or plate, preferably of slightly tapered length, which can be readily adjusted by the maintenance toolmaker in order to take up any slackness which might arise due to wear between the slides and their guideways.

In addition, it would be advisable to arrange for some simple means for holding the lateral slide in the opened position in cases where the movable block has to move so far as to cause the actuating pins to pass clean out of the lateral slides. Where this latter takes place there will be a risk of accidental moving of the slides and possible jamming, and damage when the blocks are brought into the closed position again, as the pins will not then enter into slides. In a previous section, viz., on page 492 of "Plastics" for October, an effective construction for performing such a slide retention was described and illustrated, which arrangement would be readily applicable in this present instance.

As will also be seen, provision is made for ensuring that the actuating pins cannot be forced backwards out of their socket holes in the stationary block during closure. There will be considerable drag upon each pin when the mould blocks are being closed, and in the case of a pin or its hole in the slide having become roughened on their surfaces due to lack of oil or abrasive action, the normal friction on actuating pin will be considerably increased, sufficient, in some instances, to force them back a slight amount.

Such positive lock is secured either by attaching strips to rear of the stationary mould block, which can bear against the head of actuating pin, as here illustrated, or locking screws could be provided passing through mould block and engaging a dimple or flat formed on the head or shank portion of the pin as desired.

In designing such a type of lateral slide mould some attention must be directed to the matter of actuating pin length and angle of inclination. The writer has found that when the pins are situated at more than about 15 degrees from the parting line of the mould block efficiency very rapidly declines, and a too steep angle will impose a great load upon the machine and generally make for stiff working of the mould.

Similarly with respect of their length, if this is made too long it is difficult to avoid deflection, and a good working rule is to maintain this dimension as far as practicable to within eight or ten times the outside diameter of the actuating pin. Where possible, the diameter should be kept large and the length shorter than the maximum limit here suggested.

Another useful plan is to provide such pins with side flats in order to reduce friction on that portion of the pin where it is not important that it should fit within the

hole in slide. This is indicated by the small sectional cut on end of lower pin in B Fig. 10.

The maintenance attention required by such a mould construction would chiefly comprise regular adjustment of the lateral slides and their gibs to ensure their smooth working without any slackness or side play. It would be necessary to remove these slides every time the mould is withdrawn from a production run in order to effect a thorough cleaning of the guideways and so on. Some attention would have to be paid to lubricant; to provide adequate supplies of oil being deposited upon all important points. The actuating pins would have to be frequently checked for security of fastening, straightness and signs of surface wear. The mould should be well cleaned and then closed so as to be able to test the sealing at parting-line edges of the main mould blocks. Continuous working may cause a slight distortion of the blocks themselves, which will be reflected in the lack of seal of these parts.

The finished products should be very regularly tested in the manner described in earlier sections, to ensure that errors or slight faults are not developing which are unnoticeable in the mould itself.

Generally speaking, though, the design should give very prolonged usage before any harmful signs of wear arise.

Of course, it will be appreciated that it is possible to arrange for the slides to travel not only horizontally or vertically, but at any desired inclination between. This gives considerable flexibility to the designer and mould engineer, and offers great convenience at times. Moreover, several slides can be simultaneously operated with one opening movement of the movable mould block.

In this latter connection a point well worth bearing in mind when constructing such a multi-slide mould is so to arrange the actuating pins to give several of the slides a slight dwell at the very commencement of the opening movement of the movable block. This may be advisable in order to reduce the initial load on the machine. In practice, much smoother mould operation will be secured if each slide begins its opening movement slightly behind its neighbour. Failure to arrange the pins in this manner and for this purpose may result in a very jerky, strained movement during each mould opening action, which will make for increased wear.

When the threaded cavity in the lateral slides becomes excessively worn, etc., it is an inexpensive matter to scrap them altogether and to fit new lateral slides complete with a fresh cavity, hence there is much less reason or excuse for continuing the mould in operation with worn thread forms or faulty sizes, than there would be if the cavity were cut directly into the main blocks themselves.

The Interposed Cavity-plate Type of Mould

The last design of mould employed for forming external threads on an injected moulding is shown in the sectioned illustration in Fig. 11.

In moulded articles which are to have threads on their largest diametered portion, moulding is often most economically and satisfactorily carried out by using a loose plate interposed between the two mould blocks and of a thickness equal to that of the length of thread portion being moulded. This plate is provided with a threaded hole which is, in fact, the cavity, and after injection both interposed plate and its component are ejected from the movable block, the finished article then being screwed through the plate.

This is clearly illustrated in Fig. 11, and whilst it is a very economical method of construction it is worth while considering its various features because unless care is exercised considerable troubles may arise which will entail repeated attentions from the mould tool-maker.

In the first place, it will be observed that, by interposing such a plate between the movable and stationary mould blocks, two parting lines are in effect created. Thus the finished moulding may be expected to have two peripheral flashes, one at the extreme right end of its

threaded portion, and the other at the left-hand end of the threads.

Some designs simply use a flat plate, this being located in correct alignment with mould blocks by means of the normal dowels provided for these latter members. In this illustrated instance, however, a stepped or recessed plate is employed so that the correct registration of this interposed plate is made independent of the dowels. As will be observed, this is simply accomplished by first turning a circular register on the parting-line face of the movable block, making this ample in length as shown. The rear face of the interposed plate is similarly bored out so as to be a snug slip fit over this register. The threaded cavity ultimately formed in the interposed plate should, of course, be located exactly central with the recessed portion at back.

In this example ejection of the finished moulding is secured by arranging the ejector rods to pass through suitable guiding holes in the movable block, and to impinge upon the rear (left-hand) face of the plate. As the movable block opens along line indicated by arrow, a point is reached when the movement of the ejector rods is arrested, thence the continued movement of the block will cause the rods to pass within same and push off the plate and the moulded article.

The article has a large cored hole leading in from its threaded end, this being formed by a core housed in the movable block. This core member is fixed therein as the moulding and plate together are pushed off the core during ejection.

In actual production operation with a mould of this type operation snags are apt to centre around the following points.

Since two parting-lines exist, the risks of inadvertent lodging of excess particles of plastic material, oil, or dirt accumulations are, in fact, doubled, hence much greater care will have to be observed by both operator and maintenance engineer in keeping such faces clean.

Then very often where the length of threads is extremely short this will mean that the interposed plate is correspondingly thin. Where this occurs, greater care will be required in handling such plates whilst unscrewing the finished mouldings, and when inserting them between the mould blocks in readiness for the next injection shot. Very thin plates are far more easily buckled, distorted or damaged by too rough handling.

For this reason, then, the writer would strongly recommend a very careful testing for flatness of all interposed plates after each production run, with constant watch being maintained during operation for the early signs of such distortion, etc., revealed by flash on the finished parts.

Where the method of ejection is as shown here, i.e., by direct contact of rods on to the interposed plate, it is essential that the rods be caused to move in exact unison. One can easily visualize the trouble likely to arise if, say, the upper set of rods were to commence movement slightly ahead of the lower set, or vice versa. The effect would immediately be to tilt over the interposed plate on its circular register, or the mould dowels, as the case may be. This would cause it to bind, jam or fully lock if the discrepancy of ejector rod movement were to be great. Even a very slight misalignment of this character would impose additional resistance upon the register, etc., which member would more speedily wear and lose its initial degree of accuracy.

The observant maintenance engineer would, therefore, subject such a mould construction to a sound test to ensure correct contacting of the ejector rods in the above way.

In cases where very high rates of production are required from such a mould. it might prove economical to provide the circular register recess at rear of interposed plate with a specially hardened replaceable sleeve or ring, so that any wear eventually arising could be readily obviated by simply fitting a new and proper size ring.

The circular register should be well removed from the edges of the mould cavity as shown, otherwise there will be the risk of a flash over should the mould blocks fail to seal. If plastic material is allowed to find its way into the register

recess considerable difficulties may then be experienced in ejecting the plate.

In the interests of production it will be necessary to have a number of these cavity plates, so that one operator can be unscrewing finished mouldings whilst the machine operator is enabled to proceed with moulding without interruption save that required to slip on a plate to the register on movable block. Such interchangeable plates should, of course, be very accurately machined and made identical in every respect, and they naturally receive the same close attention from the maintenance engineer as that afforded the moulds themselves.

Another method sometimes employed for locating and positioning the interposed plate in the mould block is to machine the parting-line face of this latter unit with a rectangular slot of a depth exactly that of plate thickness. This slot does not usually pass clean across parting-line surface from top to bottom, but is stopped short of bottom edge by a small amount. The plate is then made up to be a slip-in fit within this slot, and when resting on its bottom end is positioned so as to bring the threaded cavity in correct position. Clearance holes are provided through the plate for the passage of the dowels.

With this form of plate mould, however, ejection cannot be made on the plate as conveniently as in the illustrated design in Fig. 11, but it does enable fairly quick production to be secured, with a minimum of time lost on fitting or removing the threaded core plates.

The maintenance services likely to be required with this latter adapted mould construction are very similar to those described at some length. Cleanliness, lubrication, and well sealing parting-line surfaces should be the main objectives to be aimed at in operating these moulds.

Additional Mould Block Registration

In connection with all five mould forms already considered, one point has been strongly emphasized, that is the absolute need for maintaining correct alignment or registration of the movable and stationary mould blocks. It will be remembered that the writer has suggested additional dowels, or parts of greater size, in order to eliminate all possibility of misalignment, which would prove fatal to the accuracy of the finished threaded moulding.

At Fig. 12 is shown diagrammatically an illustration of a very simple, effective, yet inexpensive method to be adopted whereby the mould blocks can be accurately maintained for prolonged periods of use, whilst any wear is easily neutralized.

On each side of the stationary block shallow parallel grooves are machined

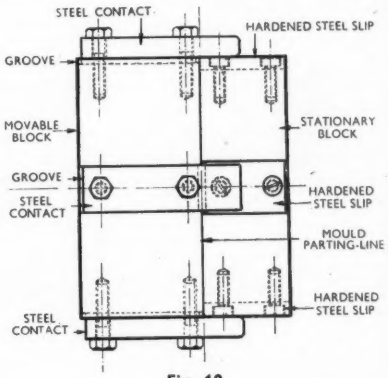


Fig. 12.

into which are then fitted specially hardened steel slips. They are secured in place by means of small socket-head screws, of the Allen type preferably, and their upper surface should project a small amount beyond edge of the block.

To the four sides of the movable block steel contact plates of the shape shown are attached, again by means of fitment first in a parallel groove, and a number of socket-head screws. These plates are so located as to overlap exactly the steel slip pieces let into sides of opposite block.

In the attached illustration the blocks are shown in the closed position, from which it will be clearly understood how this additional registration means functions. Each of the four steel contacts on the movable plate should be touching

the top face of each slip piece in other block. The sectional thickness of the contact plates should be fairly large so as to ensure a very stiff unbending plate, whilst the securing screws should be as close as practicable to end of plate normally bearing on the slip plate let into other block.

Dowels are also used, of course, the function of the foregoing provisions being to supplement the action of these former members. Thus, in the last 1 in., say, of closing movement of the movable block all four contact plates will engage the fixed block and so immediately correct any slight sideways misalignment between them. Adjustment is very simply accomplished by removing a little stock from the underside of the steel contact plate concerned so as to bring it once more into close sliding contact with its mating slip piece in stationary block.

This method of extra registration is, of course, applicable to all the forms of moulds here discussed, as well as those mentioned in the previous section, and will be found particularly beneficial in the case of heavy or bulky moulds, where great weight or stress is normally imposed upon the dowels.

By locating such pieces on the exterior of the mould the task of keeping them clean and well lubricated is also much simplified, as it requires but a few glances to assure the operator that cleaning is needed, or that lubricant is lacking.

Thread Taper

The details of plastic mould construction have, of course, to be carried out within very close limits; it is, indeed, essential that the mould be made with far greater precision than is practicable or needed in the finished moulding. Especially is this the case in respect of threaded mouldings requiring hardened and ground threaded core members for the formation of the finished threads.

In manufacturing such threaded cores or cavities, as the case may be, the mould engineer will work to extremely close tolerances of both size and surface finish.

But the limits usually specified on the threaded component are those required for a machined article, as produced by repetitive machine manufacture. The plastic moulder and mould engineer will thus be able to make very good use of the difference between the limits on the proposed mould and those permissible to the finished threaded moulding by employing it to provide a slight degree of taper on the length of thread to be formed, yet at the same time keeping the finished article within the high and low limit levels applicable to the work.

This will be found of very material assistance, especially in those mould designs where the finished part has to be unscrewed from the mould block cavity, insertion disc, or interposed plate, as previously dealt with. Even a very slight amount of taper on the threads reduces the risks of the moulding binding on the cavity threads during removal, thus making for speedy ejection.

Incidentally, the user and originator of the moulding design should always very carefully study any projected moulding in order to provide the widest size limits to the moulder, so that he in turn may be enabled to impart the maximum degree of taper on all threaded portions of a moulding. In this way economies will result and the work of the moulder much facilitated.

Internal Threads

Although the five designs of moulds for moulding external threads already discussed above do not constitute a complete survey of commonly used constructions, sufficient has been said to indicate the methods employed by mould engineers to form externally threaded articles, and, at the same time, to illustrate some of the many operating snags associated with those designs.

It is now necessary to devote a similar consideration to the question of mould internal threads, and here, again, several designs and methods of construction are employed, but it is proposed only to consider the simplest forms of construction.

Internal threads can be moulded in

several ways Thus, loose core pieces can be used, these being capable of removal from the finished moulded article after ejection somewhat after the fashion of externally threaded parts when produced in the mould block cavity, threaded insert, and interposed plate external thread moulds previously studied.

Or the threaded cores can be mounted in such a manner within one of the mould blocks as to be rotatable by either manual or mechanical means so as to unscrew them before ejection of the part from the mould.

Alternatively, in the case of a multi-impression mould for producing a number of small-sized components, the threaded cores might conveniently be connected together by gears or chain so as to operate

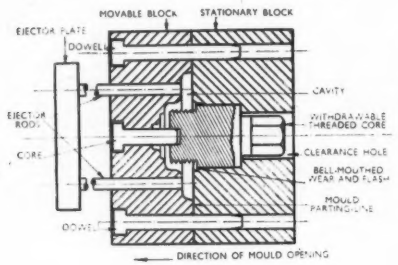


Fig. 13.

each core piece at the same time. Where this method of core extraction is employed, it will be very advisable to arrange for each core to be threaded on the portion seated within the mould block so that reliance is not made upon the moulded thread of the component during ejection. This master thread should be very carefully produced and maintained in good working condition, otherwise torn threads in the finished plastic article might result. Of course, it is true that only a mould of this type will justify itself when very large quantities of parts are required, but production is very considerably increased, because hand unscrewing of cores is entirely eliminated.

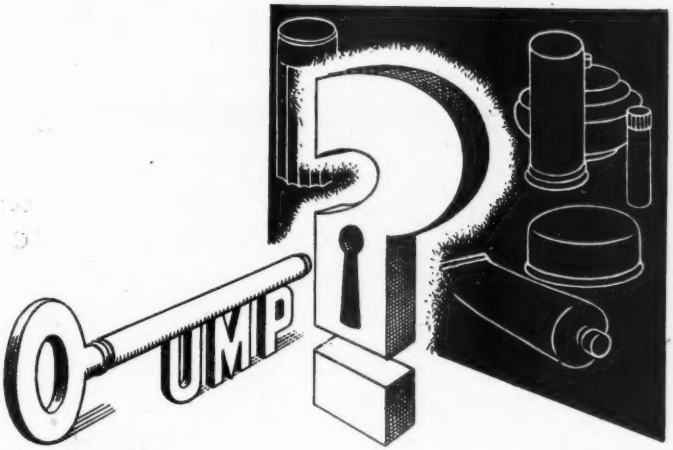
Fig. 13 shows a sectioned view of a completely assembled mould for making a ring component with a larger threaded internal recess at its right-hand side.

The method employed for obtaining the internal thread is a very common one, but none the less interesting to the mould maintenance engineer, because it affords a number of guides to improved constructional and design features likely to result in better working and production, as well as greatly reduced maintenance services.

The whole of the cavity, excepting a small spigot portion, is contained in the movable mould block, whilst the detachable core piece for forming the internally threaded hole therein is housed in a bored hole within the stationary block. As will be seen, this hole is stepped, being smaller in diameter at the rear (right-hand side) of block. The withdrawable threaded core member is made with a plain cylindrical shank so as to be a free sliding fit within the largest diameter of the hole in fixed block. At its extreme end, at the right-hand side, that is, the shank is reduced in diameter and formed hexagonal shape, as shown, the most convenient spanner size being selected. This hexagonal shank is made well clear of the smaller diametered hole in block.

When this core is situated within housing in the mould block it is located in correct endwise position when bearing with its shouldered portion up against the internal step formed by the two diameters of the bored hole as shown. When the withdrawable thread core member is in this position, it will be observed that the end face of its hexagonal shank is slightly below or within the rear face of stationary mould block, so affording clearances and preventing interference with attachment of other members to rear face of block. The other end of this core carrying the thread form is also properly located in relation with the mould cavity formed in the movable block.

A small core pin is permanently fixed in a horizontal hole through movable block, and is made long enough to pass well through the mould cavity and into a matching hole machined centrally up the end of the detachable core.



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The illustration also indicates the method used to eject the finished moulding. Rods pass through holes in the movable mould block, their inner end faces joining up exactly with the base wall of the cavity, so that when a plastic moulding has been made the rods will bear directly against its left-hand side beyond the central boss. When the movable block is actuated for opening the moulds, it travels towards the left in direction shown, bringing with it the finished moulding plus the detachable thread core, which latter is drawn out of the hole in fixed block. At a certain point throughout this opening movement the ejector plate to which the ejector rods are secured is arrested from further leftward travel, thereby causing the rods to be depressed within the movable block as this part continues to travel. Thus the moulding is pushed clear of the cavity.

The remaining operation will then consist of unscrewing the core piece from the moulding and resetting the former in the stationary mould block in readiness for closure of mould and the next " shot."

The maintenance engineer should note several features about this design which may entail the development of numerous faults both in respect of the products and the mould itself, the elimination of which may involve repeated attentions and corrective measures on the part of the maintenance toolmaker.

(1) Because the plain cylindrical portion of the detachable core is made smaller in diameter than that of the spigot portion of cavity formed in the stationary block, an additional flash line will be created around this portion of moulding.

(2) Also because of this small diameter of the detachable core should any appreciable wear take place between the plain shank thereon and the sides of the guide hole in the stationary block, an extended flash will be noticeable upon the right-hand end face of the spigot on the finished moulding. This would create an additional fettling operation, which latter might prove objectionable in cases where the length of spigot and its end face had to be maintained within close limits.

(3) It will also be noted that the shoulder formed in the guide hole in the stationary block, which, as previously explained, is used for securing location of the core piece, is hardly substantial enough to withstand satisfactorily the considerable pressure upon the end of the core member during injection of plastic material. It should be appreciated that there will be a very appreciable force upon this core, and a too small registering shoulder, such as here shown, would certainly lead to trouble.

(4) Again, because this step in the core guide hole is positioned so very deeply within the stationary block an operator would experience some difficulty in maintaining the hole clean and, in particular, preventing excess plastic, dirt, or other extraneous substances from lodging on shoulder face. Should this take place, it is clear that the detachable core will be inaccurately located in relation to the cavity.

(5) As the detachable core is not secured against rotation within the mould housing hole, there would be a tendency for the core piece to shift over during moulding, due to the air turbulence set-up and the frictional pressure of the incoming plastic material.

(6) Should wear occur between the core and its guide hole corrective measures would be fairly considerable, comprising the making up of an entirely new core piece, even though the thread form were comparatively unworn. Such a new part would have to be slightly larger in diameter on the plain shank so as to fit within the reground-out hole in block. Or if most of the wear was found to be within the hole this latter would have to be machined out much larger in order to insert a permanent liner whose bore was the correct size to suit the existing core piece. But in machining out such a worn bore the machinist would encounter extensive difficulties in the shape of correctly setting up the block prior to machining. Unless this was correctly performed, the final result of such a correction might be the eccentric location of the detachable core member in relation to the mould

cavity in opposite block. It is always advisable to bear this in mind when designing and constructing a new mould. The writer can recall numerous instances which have arisen from time to time where the necessary corrections for wear have entailed extremely awkward and protracted and costly setting-up or machining operations, due mainly to the inability of an operator accurately and simply to set up the worn block or other member.

(7) A further possible snag relates to the handling of the core piece during unscrewing operations from a finished and ejected moulding, and the reinserting of the core prior to injection. Care would be necessary in order to prevent the delicate and highly polished threads from becoming damaged due to accidental dropping, contact with other articles on the bench or stripping stand, etc. When replacing the core within the stationary block it would be very easy to get the shank end across and jammed within its hole, in which event there would be a great temptation to the operator to use a piece of metal or hard substance to hit the end face of the threaded portion to bring the core square and in line with its guide hole. Such practices would prove exceedingly harmful, leading as they very often do to chipping and snapping away of the first thread on core. The operator should be very carefully instructed and warned against this faulty handling and risky treatment.

In fact, handling core members used for forming internally threaded parts calls for greater care and appreciation of possible dangers than in the case of those required for making external threads, as will be appreciated.

In cases where a single mould construction is supplied with a number of differently sized detachable cores of the type here illustrated, as, indeed, could very easily and inexpensively be performed provided all cores were made the same outside diameter on their plain shank portion, the operator should be provided with a designed wooden box in which the spare cores could be safely stored.

Such a box should be split up into conveniently sized and isolated compartments so that no two cores could bump or contact one another, and, of course, should be supplied with a substantial locking arrangement. All such mould accessories would be subjected to the same stringent and regular inspection and test as afforded to the mould itself, and, moreover, should never be left lying about in the moulding shop or on benches and stands, but always returned immediately to the maintenance toolmaker after use for checking and inspection, and then returned to the authorized storage department. Many excellent moulds can be ruined or drastically diminished in value and efficiency because of the lack of proper care given to essential auxiliary parts of this kind especially.

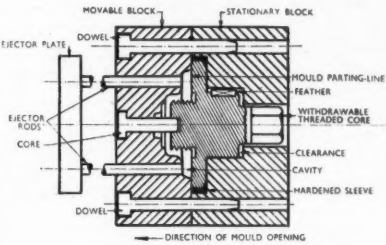

Fig. 14.

At Fig. 14 is shown a much-improved construction for the moulding of the same plastic moulded article as before.

In the first place, it will be observed that the detachable core is made with an enlarged flange whose outside diameter is considerably larger than that of the cavity in the movable block. The parting-line face of the stationary block is suitably recessed to allow this flanged portion of core to be a snug fit, and, of course, deep enough to bring the latter flush with the parting-line surface of block on its front face.

The advantage of this enlarged flanged form of core is that it removes entirely the extra flash line around the end spigot noticed in connection with the design shown in Fig. 13.

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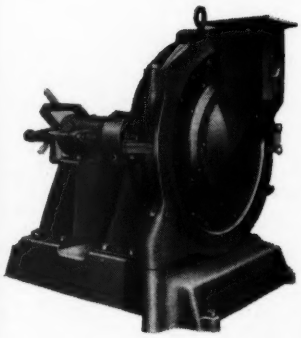

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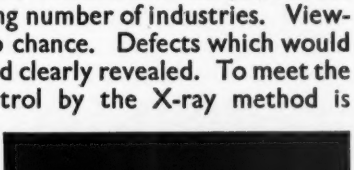

Radiograph of moulded assembly showing incorrect location of metal insert.

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Secondly, this recess in mould block for receiving the flanged portion of the detachable core is lined out with a specially prepared and hardened-steel sleeve, which is readily renewable if and when required by reason of wear or damage, etc. Should wear occur, a new sleeve can quickly be inserted; whilst should the wear take place on the periphery of the core flange it is a very simple matter to set up the piece for cylindrical grinding to remove the worn portions, and then to fit a suitably bored sleeve within the block. Such corrective operations could, in fact, be performed numerous times, if necessary, without bringing the intersecting line formed by junction of flanged and sleeve bore too near the cavity edge, thereby avoiding the dangers of flash-over.

Thirdly, this form of detachable core is located in proper endwise position by contacting with the bottom face of the shallow recess and not by the bearing of the shoulder on its smaller diametered shank against the step in the housing hole, as before described in reference to the previous construction. As will be seen, a clearance space is provided at this point. An operator would find it a much easier and quicker task to clean out the large shallow recess against which the core is to be located.

Fourthly, it will be seen that the core is keyed within the smaller bore in a stationary block by means of a hardened-steel feather sliding in a keyway. This ensures an absence of all rotation and maintains the core always in a given radial position.

If desired, a further advantage to be gained could cover the more effective locking of the core within the stationary block especially during injection. This could readily be secured by using either a hardened-steel ball or vee-shaped plunger to engage a dimple or slot on the plain shank of the core. The ball or plunger would be housed in the stationary block so arranged that the ball, etc., could not fall into the bored hole when the detachable core was withdrawn by the movable block. A powerful spring would be employed behind the ball or plunger and would force the ball to engage its dimple when the core piece was in correct position for moulding. This design is of fairly common knowledge, hence illustration is omitted. It is mentioned, however, as being one of the simplest ways in which a more positive retention of the core can be made, and yet allowing instant withdrawal to take place when the injection cycle is completed and it is necessary to open the mould blocks.

In the case of a very heavy detachable core, it might be necessary to provide two or three ball or plunger location devices. Their maintenance would be a very simple matter largely being confined to renewal of fatigued springs, or repolishing of the worn ends of the locating plunger, with an occasional replacement of a badly shaped ball.

The extent of maintenance service likely to arise in this last mould design is comparatively small in comparison to that which might be expected from the design in Fig. 13. There would have to be very accurate dowel registration of the two blocks of course, and the dowel guide holes in the stationary block could usefully be bushed in the manner described in a previous section of this series of articles.

Care would also have to be regularly devoted to ensure that the core was a free sliding fit within the stationary block, as any undue friction caused by lack of lubrication, bruises, etc., would cause an additional drag on mould opening and possible stressing of some other mould or machine member. Periodical inspection would also have to be made to check the condition of the hexagonal head of core. This might, in time, become badly bruised and knocked about sufficient to cause a tightness of core within the block.

The base of the recess for housing the core flange should also be kept very clean and clear of all particles of material. But it should be noted that even though some accumulation should arise between these two faces sufficient to hold the core slightly forward beyond the parting-line surface of block, no great flash would

result because the front left-hand end face of the flange would still bear up against the parting-line face of the block, and prevent opening from sides of the cavity.

Very frequent inspection and gauging of the thread form on left-hand end of the detachable core would, of course, be necessary, as damage is likely to arise from a large variety of accidental and often unforeseeable causes. But some risks of such damage would be avoided owing to the greater ease with which a core of this design can be inserted within its housing hole, and there should be little need to force in the core in order to correct jamming or crossing.

In those cases where the size tolerances are somewhat ample enough it is a good plan to remove all such detachable cores and return them to the maintenance man for cleaning up and repolishing on the thread flanks. There is a strict limit to such work and in the case of the high precision part it may be impossible altogether, but often the dimensional limits are such as will allow for the removal of a fraction of a " thou " from each side of the thread flank in order to recover original polish, in this way promoting continued easy trouble-free ejection of the moulding and unscrewing of the threaded core.

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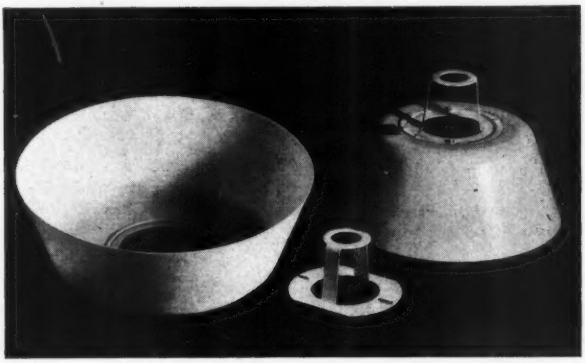

The lighting division of E. K. Cole, Ltd., is introducing an interesting range of plastic fittings, the first of which are now available. They are being marketed under the trade name "Plastalux," and a particularly attractive feature, which will appeal because it cuts installation and maintenance costs, is the patented one-piece gallery. No screws or loose parts are used, the shade and gallery being assembled by a simple " twist-grip." This means that the shade can be quickly fitted or removed, leaving the one-piece gallery in position on the lighting flex. The plastic shade is unaffected by water, oil, grease and corrosives.

Already available are two sizes: 9-in. diameter, Type PF1 (for 40/60-watt lamps) at 4s., and 11-in. diameter, Type PF2 (for 75/100-watt lamps) at 4s. 9d., both plus purchase tax. Further types will be announced as they become available.

There should be a big market for these low-priced fittings, both for domestic and industrial use. Full details can be had from Lighting Division, E. K. Cole, Ltd., Southend-on-Sea.

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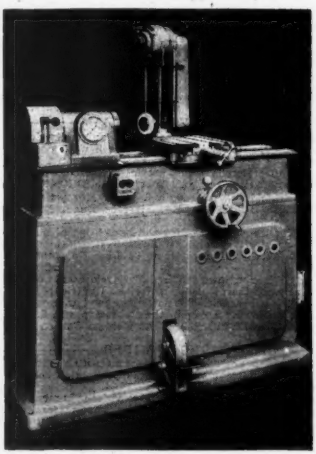

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